Fusion by Pseudo-Particles, Part 1
Past, Present and Future

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— Abstract —

There are urban legends and documented facts about mysterious fuel-free energy production devices witnessed during the last century. In Part 1 of this three-part series, a dozen of them are described along with their salient technical features, and about their known, and suspected, features. It seems that more low-energy nuclear devices in various forms have been demonstrated than previously thought. Thus the missing pieces in the puzzle are completed. Electrical energy-producing LENR devices were demonstrated by Tesla and Moray as early as in the 1920s. Papp demonstrated his noble gas plasma device in 1968. New technical solutions have emerged since then based on phonons, polaritons and charged nanodust particles, as pseudo-particles.

Part 2, forthcoming in Issue 108, will show the importance of charge screening by real and quasi-particle emergent properties.

Part 3, forthcoming in Issue 109, will show the historical parallel with the quasi-particle-based semiconductor and the LENR mystery, and describes another possible tectonic change in the future. Finally, the drawbacks and advantages of some inventions, and lines of development, are analyzed based on their physical properties, and compared to each other and outside challengers. According to Feynman, the most important word in physics is "atom." But the most *useful* concept may be "quasi-particle."

The Past

Martin Fleischmann and fellow researchers P.J. Hendra and A.J. McQuillan discovered "surface enhanced Raman scattering" in 1974. It is a strange and powerful amplification, a resonant process due to the collective oscillations of surface electrons. They behave like particles in a self-organized, "emergent" manner.

This phenomenon is somewhat similar to turbulence, when a collection of particles acquire new, unexpected properties which cannot be derived from their single-particle properties. Thus came the word "emergence."

Fleischmann realized the value of the collective oscillation, changing his view toward natural phenomena. In fact, he stumbled onto one member of a populous family of quasi-particles. His perception about a collective surface oscillation guided his research towards LENR phenomena in the area of electrolysis. He was not aware of its predecessors (the subject of this paper), who found and lost similar processes. Fleischmann made history by calling attention to a group of different nuclear phenomena.

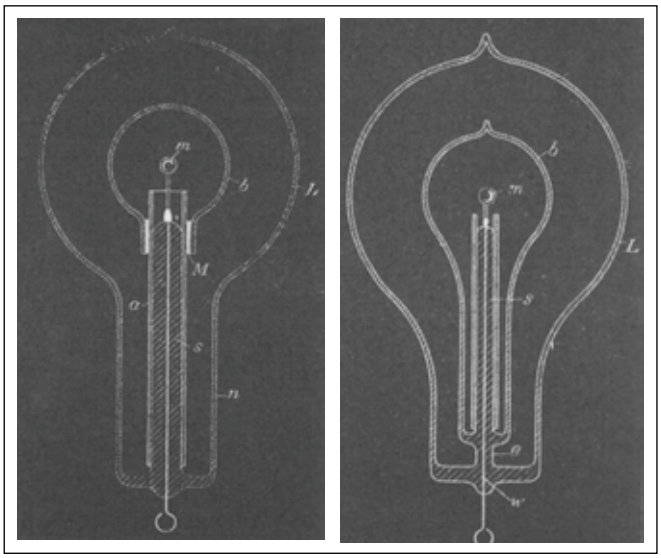

Figure 1. Spherical "carbon button" discharge tubes invented by Tesla in the 1890s. They were capacitively driven by polarization currents.

Tesla – Carbon Nanodust

There is a persistent urban legend about Nikola Tesla, the prolific Serbian inventor. According to some contemporaries, he developed an electric car in the 1930s. He converted a Pierce Arrow car removing its tailpipe. He claimed that his greatest achievement was not alternating current or the radio, but a high voltage tube which could produce energy and transmute materials. This story has usually been dismissed as nonsense. Now in the light of emerging LENR experience, this could have been true after all. He claimed "nature has stored up in the universe infinite energy" (Columbia College Lecture, New York, May 20, 1891).

Tesla demonstrated "carbon button lamps," spherical gas discharge devices in public lectures (London 1892, Philadelphia 1893, U.S. Patent 4,546,22/1891). These plasma devices were driven by high voltage polarization currents, which emitted suspiciously large amounts of light (U.S. Patent 593,138/1897, shown in Figure 1).

Carborundum (carbosilicate dust and/or carbon nanotubes) in a resonant plasma is a possible source of the LENR phenomena (discussed in Part 2). Some poor quality photographs of Tesla's spherical tubes were published in his legal records. Today the single-wire polarization current technology, which is required to resonate the plasma, has practically been forgotten, revived only by some amateur researchers. But our understanding of the principles of dusty plasma has been steadily growing in the last decade, and institutional science is finally catching up.

Tesla became an outcast in science by the 1930s. Physics

was just over its "golden years." The mainstream was involved in quantum mechanics, and the golden years of nuclear physics was about to come 20 years later. No one has entered Tesla's footsteps ever since.

The closed-circuit plasma devices presently used are not suitable to exploit the dusty resonant plasma LENR process, as they cannot extract excess energy. RF and microwave driven plasma, developed decades later, were already workable methods but they exploit only excess heat. For direct extraction of electric energy, the single-wire technology is simple and straightforward. No wonder the same discovery has emerged again by using Tesla's single-wire invention.

Moray – Plasmon Polaritons in Microcavities

Henry Moray, a self-taught electrical technician in Salt Lake City, stumbled onto a strange effect as a radio amateur at the age of 15, in 1909. By 1911 the device illuminated a 5 - 10 Watt incandescent lamp, and did not improve until 1925 when it increased to about 70 Watts. By 1938, Moray demonstrated a device producing 4 - 5 kW electric energy several times. By the 1940s it rose to about 20 kW.

Moray modified a crystal radio, with the antenna serving as a high voltage low current power supply. His only patent (U.S. 2,460,707/1949) discloses a series of gas discharge tubes driven by Tesla-type single wire polarization currents. During decades of development, his multiple-tube device yielded 5 - 20 kW of electric energy, silently, continuously and without much heat. Moray's high frequency tubes of different designs emitted bluish light in the presence of high voltage sparks. The thin wires in the device and the sensitivity for one's vicinity to the power output of the device are telling signs of capacitively-driven discharge tubes.


T. Henry Moray in 1932.

According to his patent, Moray used a large surface, intermittently excited cathode, in a low pressure discharge tube. The cathode was made of "Moray metal," an alloy containing sulphur, aluminum, lead, etc. In a high voltage, low pressure environment, the cathode surface becomes large, spongy, and full of small, micron-sized cracks and cavities, like Swiss cheese. This can be a "nuclear active environment," a term coined by Edmund Storms. Metal dust particles and surface plasmons can be created at the nanometer scale, which are essential ingredients of some LENR processes. The tubes contained some water vapor, thus hydrogen, reading between the lines of his book and patent (*Sea of Energy in which the Earth Flows*, T. Henry Moray, 1st - 5th edition).

Moray kept a paranoid secrecy about the technical details of his "radiant energy" device, and had a long, futile fight with investors and partners, such as Carl and Henry Eyring, and the U.S. Patent Office. Though he lived until 1974, Moray never disclosed his invention, but kept on speculating copiously about the nature of the excess energy, resonances and plasma oscillations. Though dozens of people saw the working device, and half a dozen testified about it for a public notary, this invention is lost once and for all (see Figure 2).

Moray's device didn't require input from the grid, but a large antennae and grounding, as demonstrated several times in the deserts of Utah. The low current, high voltage, low power input from the antenna was enough to drive a first tube, which drove a second resonant tube with higher pressure, which fed the third-stage tubes, which yielded several kWs of electric power.

Moray skipped later aerials as a source of high voltage power input, so he could demonstrate a working device in a moving car, or in an aeroplane. He had to develop his own high voltage rectifying semiconductors, in itself an important achievement—and kept it secret. His cup-like voltage amplifier (not discussed here) is also a potentially useful and forgotten device.

But his spongy alloy—the "Moray metal"—was the essential site where presumably the low energy nuclear phenomena took place. Though it was not disclosed in detail in his patent, it might be reproducible today.

In retrospect there is a plausible explanation how a

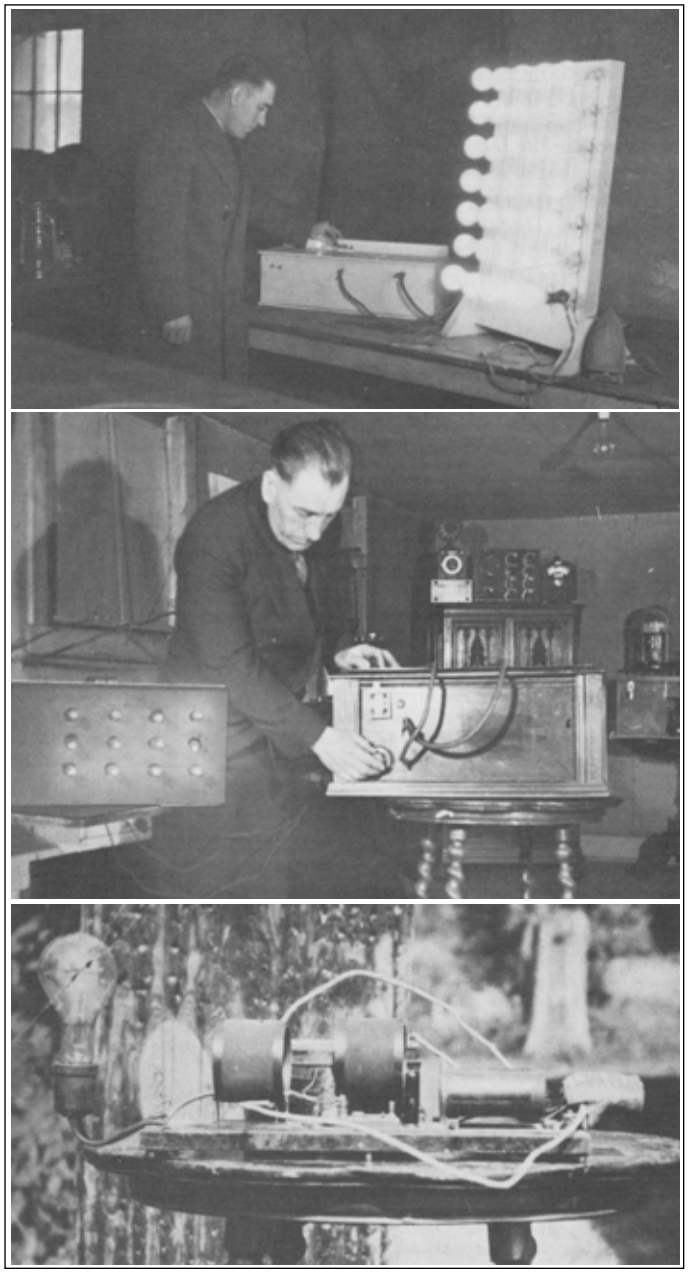
Figure 2. Demonstrations of the Moray device.

teenage crystal-radio fan in Utah stumbled onto an excess energy effect. Ostensibly he replaced the unreliable galenite crystal diode with a wire corona discharge tube, which was capable of rectifying, first at atmospheric pressure and later at lower pressures. The dry Utah desert air gave him a permanent advantage hard to find elsewhere: extreme high voltage between the aerials and the ground, up to 100 kV.

If the inner tube (the cathode) was made of a slightly roughened stainless steel, or a lead-sulphur galenite alloy with some surface protrusions and cavities—due to cathode bombardment—Moray created surface plasmon polaritons without being aware of it (see Appendix).

By tuning the modified detector radio circuit, Moray stumbled onto two distinct phenomena. First of all, the wire corona discharge tube became a sensitive microphone, and the resonant circuits amplified the acoustically modulated plasma oscillations; thus anyone could hear the noise of rain far away or the sound of a distant train. He proudly showed off this device, which might have already been a modified circuit.

Moreover, by tuning his radio into the frequency range of regular Trichel type negative corona oscillations Moray might have heard an unusually strong noise in the earphone. This aroused his curiosity enough to continue the experiments in 1909.

Hundreds of other radio amateurs might have got up to this stage, but apparently no further. (The author read a letter of a Hungarian crystal radio amateur who got into this stage in the early 1950s.)

Moray went further. He replaced the earphone with a 1 mm wide spark gap, having an electric output of about half a watt. This was much more than the ordinary output of the pin rectifier detector radio, having an output power only in the order of milliwatts. This was the fundamental setup that he showed to his teenage friends. It took him about ten years to figure out the relative importance of the different parameters. He reached the 50 - 100 W electric power output with an approximately 5 cm diameter gas discharge tube, having a cathode approximately 2 - 3 cm in diameter, whose material must have been "Moray metal." He certainly perfected one of the first R&D processes in nanotechnology. Lead, sulphur and aluminum in his alloy (a version of galenite crystal) served the same purpose as aluminum in the "Raney nickel" catalyst—to have a large surface. After some heating or cathode bombardment, these soft materials left the surface, leaving a number of sub-micron size cavities like Swiss cheese. This was the "nuclear active environment," due to the formation of a surface that was needle-like or cavity-like. Surface plasmon polariton resonances might have been generated by low power resonant electric circuits, excited by high voltage, high frequency electric fields, which in turn generated low energy nuclear phenomena. (The plausible mechanism of the polariton-based LENR will be discussed in Part 2, and more specifics of the Moray patent in Part 3.)

Thus Moray addressed the most important issue—reliability—like Tesla with his own "carbon button lamps." Other inventors discussed below were not so fortunate, as other inventions did not have such a good "engineering environment" as Tesla's volumetric, dust-based or Moray's surface-based LENR processes.

The next challenge, to increase power to the commercially interesting 10 - 20 kW range, took about 20 years.

One of Moray's insights must have been that a series of coupled resonant circuits need to be used for higher power output. But the tube required ever higher voltage input for lower frequencies—a real challenge.

Moray correctly noted that when excess energy is generated, "inertia sets in." That means the high frequency resonant electric circuits can drive sub-harmonic plasma oscillations in resonance. This is a typical feature of resonant ion acoustic oscillations, which were "discovered" decades later by mainstream scientists. (See Masana, R. and Daquq, M. 2012. "Energy Harvesting in the Super Harmonic Frequency Region of a Twin-well Oscillator," *J. of Appl. Phys.*, 111, 044501.)

Moray solved the high voltage input problem by rewiring the circuits, and switching to the Tesla-type single-wire technology (though he claimed he had discovered it independently).

The key element was a novel parabolic, cup-like amplifier or resonator, which is an engineering triumph itself. But he had to use high frequency, high voltage "Zener" type diodes to rectify the power impulses, to be fed to the cathodes. This was another engineering problem solved by refined germanium semiconductors.

Since he used tuned, resonant electric circuits and plasma resonances, Moray's device required some re-tuning after the initial warm up of the plasma, as several witnesses observed. The high voltage (100 kV), high frequency, capacitively driven ≈ 50 - 100 KHz device was very sensitive to de-tuning, that is to the touching of the aerials or even from someone getting very close to the device.

At first the walls of the glass plasma tubes were the source of water vapor via diffusion, providing a slow stream of hydrogen. Moray was aware of it, as we read between the lines of his books and stated clearly in his patent.

Since fine resonant tuning was essential for the device to produce energy, he was correctly convinced that resonance is a key to the production of energy. But the empty hypothesis of the oscillating Universe led nowhere.

As we shall see with other similar inventions below, the necessary scientific foundations were simply not available before Fleischmann's discovery: nanotechnology, quasi-particles, emergent multi-body interactions and low-energy nuclear phenomena. The theoretical and engineering challenges were as extreme then as they are today. The range of necessary topics is so wide and varied that in our goal-oriented, overly specialized science we cannot cope with such a technical and physical diversity. No wonder Tesla was considered to be a "wizard" of his time due to his reputation, but other researchers in this area were termed simply as crooks.

All these (and the following) inventions could have been of immense utility to mankind, but these ideas are very far from mainstream thinking. Consequently, mainstream thinking in this area is not remotely useful.

Since Moray's death in 1974, a great number of amateurs have unsuccessfully tried to repeat his work because they lacked the "right" starting point both in technical and theoretical grounds. Tesla at least made some attempts to describe the technical foundations of his invention. Thus we have his patents and lectures, with meaningful engineering ideas.

Moray left us much less, though he was also an exceptionally creative research engineer, facing extreme engineer-

ing, social and financial challenges.

In retrospect, it requires a sharp eye and open-mindedness to recognize and accept surface quality as a decisive factor in this area of research—as neither thermonuclear fusion (nor electrochemistry) demands or recognizes it as a factor worthy of consideration. This author went through it, as did Tadahiko Mizuno.

Mizuno remarked about the importance of surface features in his book (*Nuclear Transmutation: The Reality of Cold Fusion*, Infinite Energy Press, 1998). Though it is mentioned in the context of electrolysis, it applies here and to other inventions:

> When hydrogen is produced at a protrusion, the discharge reaction will be enhanced, the recombination reaction will be suppressed. . . (p. 103)

> You can heat up the lattice or expose it to a magnetic field; you can anneal the palladium [cathode] or alloy it to other materials. You can process the metal to make the surface smooth. Nothing will help. (p. 101)

> Near a protrusion discharge occurs more readily. . . which would yield hydrogen pressure reaching 10^{17} atmospheres. This far and away exceeds the 10^{11} atmospheres of pressure in the center of Sun. (p. 103)

This was a testable hypothesis with predictive capability. It was not followed.

Surface quality at nanoscale is very difficult to control and maintain in a gas discharge. As we shall see later, not all devices and processes are capable of maintaining it. Reproducibility and control are still a major concern for LENR, as well as the lack of a fresh stream of developers. Young kids no longer hang around crystal radios, as analogue long wave radios no longer exist.

Kids no longer make galenite crystals of their own (made of mainly sulphur and lead), mixing and melting them, learning with hands-on experience. Useful, down to Earth physics vanished for good.

The author has some remote experience with this technology, but it was just a string of quarrels. The sponsor and the engineers always wanted shortcuts and "compromises." They did not want a tall antenna because it is too dangerous, no sulphur and lead in the cathode material because they stink, no high voltage single-wire technology because it is "outdated" and dangerous, etc.

So after years of frustrating, endless rows, the project was a complete failure. The moral of the story: the Moray type of technology demands some uncompromising, extreme parameters, where no shortcuts are possible.

The underlying physics is absolutely alien to electrical engineers, who were raised in our conventional system of education.

Salt Lake City, Utah reminds people of LENR (cold fusion) and of the researchers Stanley Pons and Martin Fleischmann, and the year 1989. The city should commemorate Moray as well, and the date of the death of Joseph Papp because both made reliable, industrially applicable devices with direct electrical and mechanical energy output, in small, controllable, portable devices, arguably based on LENR. It is true that by 1989 they had faded from memory, but "cold fusion" returned via the back door, in a different technical setup, hopefully never to vanish again.

Moray had a small group of supporters who witnessed his experiments, among them Harvey Fletcher from Bell Laboratories and Carl Eyring. His brother, Henry Eyring, a local professor of chemistry, saw the demonstration too, but did not understand it. Therefore he vehemently denied even the existence of the excess energy effect, causing a loss of credibility for Moray. This eventually led to the demise of his invention. As a twist of history, Fleischmann and Pons worked on LENR in a building named after Henry Eyring. (Further in-depth analysis will follow in Part 3.)

What about the mainstream science of those years? In 1926, Germans Fritz Paneth and Kurt Peters realized that helium was "synthesized" in a spongy, white hot palladium tube, when light hydrogen was fed through it. This was the closest hit. (James Chadwick found the neutrons after a ten-year hunt in February 1932.)

Had they elaborated on the circumstances of their experiments—*e.g.*, temperature, surface quality and material testing—we would be smarter and better off today. A similar test was performed by Francesco Scaramuzzi in the Frascati Lab in 1989, when deuterium gas was led through hot titanium scraps and helium was observed. Unfortunately, the role of surface quality was not investigated with due diligence in these tests, but the "writing was on the wall." In the 1930s there were two working, advanced LENR devices producing electric energy. The fundamentals had already been presented by Tesla to his fellow engineers in the 1890s.

Papp – Charge Shielding by Chlorine Ions

Joseph Papp, a Hungarian-born inventor and a refugee of the 1956 Revolution, demonstrated his inert gas engine in California in 1968. His LENR engines were practically converted four-stroke internal combustion devices, but with sealed pistons, containing a mixture of water, rare gases and chlorine. The chain of collisions of inert gases (Xe, Kr, A, Ne and He) was a kind of impedance transformer. It worked like a whip with a gradually decreasing diameter. Even a modest initial wave velocity of the human hand at the thick end is enough to break the sound barrier at the thin end. Thus kicking a heavy Xe ion, a proton (at the end of a "lucky" collision chain) may produce a substantial energy (velocity). This process can yield an extremely distorted distribution of energy for the protons or deuterons in a plasma. Thus only a very small fraction of them had high energy. Some of the gas atoms were ionized, but most of the atoms were not ionized. There was another engineering trick: the introduction of some halides like chlorine, capable of forming negative ions, thus capable of charge shielding (screening or charge neutralizing if one prefers these expressions). Thus one proton with equilibrium velocity can have a good bonding and charge neutralization to a negative chlorine ion, forming a nearly neutral electrical bond. Then another proton, accelerated by a "lucky chain" of collisions, can have a high velocity, and fuse with the slow proton (or deuteron). This chain of events of a three-body interaction has a low (but not zero) probability, but that is exactly what is needed for controlled fusion. There were other minor engineering tricks as well, not discussed here, but the irreducible ingredients of a three-body interaction with charge shielding and non-equilibrium distribution are shown in Figure 3.

On the ill-fated first demonstration of the engine in Gardena, California, in November 1968, Richard Feynman, Nobel laureate and a veteran of the Manhattan Project, literally blew up the engine, killing one hopeful investor and severely injuring three other spectators. Feynman was convinced that Papp was nothing but a crook. He thought that controlled fusion can only be a thermonuclear one, which can take place only above a very high energy, consequently not in a small and cold piston of an engine. Thus Papp had to be a crook.

Indeed, Papp had a deceitful, paranoid personality, not trusting even his closest associates (see *Infinite Energy* #51 for details). Though he mastered a commanding hands-on experience with his technology, he was not much interested in the physical fundamentals. His first patent (U.S. 3,680,431/1972) contains some nonsense (like neutral electrons), but his third and most sophisticated patent (U.S. 4,428,193/1984) is crammed with a deliberately placed collection of misleading information, like the installation of high frequency magnetic field solenoids around the cylinders of his engines. He wanted to be rich and famous, and did everything to make it impossible. His former colleagues inherited this unfortunate characteristic. Fighting for his legacy, they keep on strangling each other, like the Rohner brothers, or Jim and Jake Sabori. (John Rohner's U.S. patent application is 2011/0113772.)

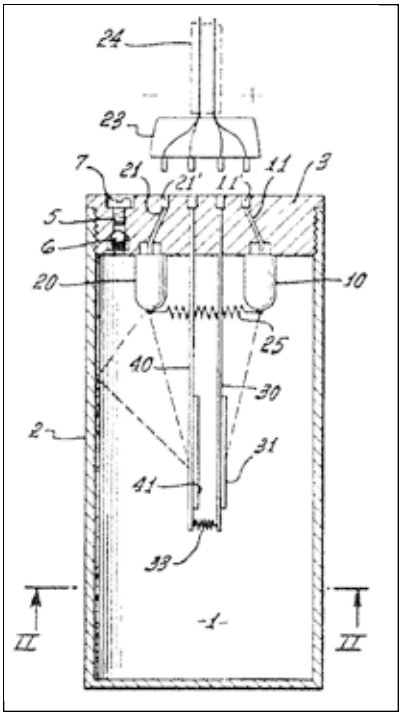

Figure 3. Joseph Papp's simplest invention—a gun with noble gas mixture.

The author has met some of Papp's former Hungarian coworkers, and received "original" blueprints, photographs, descriptions—mainly to mislead possible investors, and create a fog to mislead anyone who wants to repeat his experiments. Papp's ionization gas mixing device was clearly meant to impress (and deceive) possible investors.

His brother still lives in Hungary, but is ignorant of any technical details. According to former co-workers, Papp's father stumbled onto this phenomenon, and he was the source of the inspiration.

Jekkel – Plasmon Polaritons on Thin Silver Wires

Janos Jekkel, another Hungarian inventor and technician at the now defunct Electric Research Laboratories, stumbled onto a strange phenomenon when he wanted to build an electric oxy-gas welding torch. He wanted to dissociate superheated water molecules, simply shaking them apart by resonant high voltage, in high frequency electric fields.

He made a "T" shaped glass tube, superheated with high pressure steam (see Figure 4) and led the steam through two electrodes, made of micron thin silver wire "wool." There were roughly 20 kV, approx. 10 kHz series of one-sided sawtooth-shaped electric field pulses on the electrodes. When the device was switched on, Jekkel realized the difference between the small electric input, and the huge oxy-gas output. He kept on refining the engineering aspects of the design, because he had an internal combustion engine on his mind. The engineering challenge was to maintain the same pressure at both exit parts, which was crucial when he had to accelerate his car (a Moskvich 407).

During his experiments, the oxy-gas exploded twice, smashing all the windows of the neighbors. Jekkel claimed to have solved the problem of separating H_2 and O_2 gases with a solenoid and some permanent magnets. He got the fine silver wires from his lab, where he was in charge of developing a fast acting fuse (which he solved with these wires).

After three years of work, he made a partly successful 220 km maiden voyage to the village of Medgyes after several shorter trial runs. He was stopped and fined by a police patrol, because he had no gasoline tank. At that time, the price of Propane Butane gas was subsidized by the state, as most kitchen stoves run on it. Therefore it was not allowed to be used to run cars; they were supposed to run on gasoline, which was heavily taxed. Special permission was needed to run a car without gasoline, granted for only a few well connected persons.

On the way back, the main crankshaft broke since it was not meant to bear the brunt of oxy-gas explosions. He had to rent a car to pull him back home at a steep price.

Jekkel became fed up with the difficulties, took the engine apart and cannibalized the high voltage electronic power supply—the soul of the machine. Two decades later, when the "existing socialism" collapsed, a wealthy businessman offered financial help to rebuild the machine. (The author was part of the team.) After a few months, it became clear that Jekkel forgot all the important details. Since he had kept no logs, no documents, photographs, etc., Jekkel was unable to guide us. We tried stainless steel flat electrodes for months when he finally mentioned the thin silver wire mesh, but by then our budget and patience had run out.

In retrospect, we know that thin silver wire mesh might be the site of powerful plasmon polariton resonances—a fact not known at that time. Because all know-how about the electronic parameters of the resonant H_2O plasma smasher has been forgotten by now, there is no hope to revive this machine. Jekkel passed away on Christmas 2011. This author has met only one independent eyewitness, a former

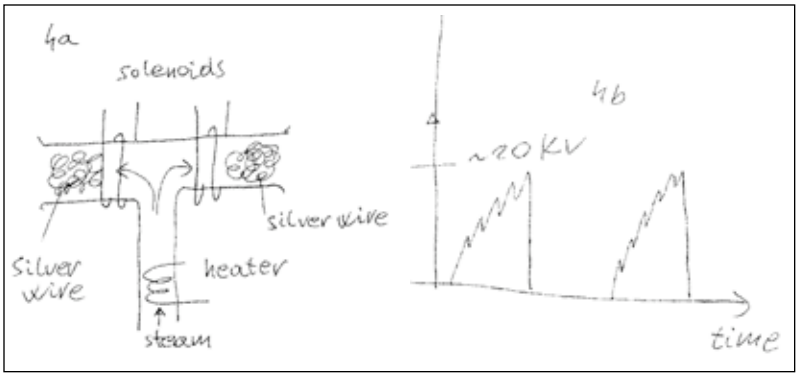

Figure 4. Schematic layout of the Jekkel tube and pulse shape.

colleague who saw the device in action but he was not interested in the technical details.

Apart from the generation of nuclear energy by the resonant plasmon polariton method, there might be other physical mechanisms involved, and it might be of practical interest to test this possibility.

Gray – Plasmon Polaritons on Wire Mesh

There is another wire mesh invention producing excess energy, by Edwin Gray. Gray has a portfolio of three patents. The first one is 3,890,545 but only the last (U.S. Patent 4,595,975/1986) contains some useful information. His device is a transient arc generator. The excess energy drives a solenoid, which drives a special electric motor, where the stator consists of permanent magnets.

The real essence is in the fine wire mesh cathode, capable of generating volumetric and surface plasmons. In a rare interview, Gray boasted that he was capable of harnessing a series of very short, sharp bursts of excess energy, and these fed an oscillatory circuit.

As usual, he was a loner, keeping the most important details to himself and disclosing only partial details. As usual, he wanted to be very rich and very famous at the same time. As usual, he died penniless, and his work has been practically forgotten.

Shoulders – Plasmon Polaritons on Needle Tips

There is a similar strange effect, found by Ken Shoulders (U.S. Patent 5,018,180/1991, or 5,148,461/1992), which belongs here. The effect takes place on the tip of a needle in a transient plasma at low pressures. At a modest 500 V difference, a bunch of electrons and protons form an interesting particle cluster, which he called an "electrum validum," on the cathode tip, creating a hole on a fine aluminum or ceramic flat anode (or witness plate). The calculations yield an astonishing amount of excess energy, up to 90 times, and some transmutation effects as well; see Figure 5.

The small area of the needle tip creates an enormous electrical field strength and gradient which no linear or circular particle accelerator is able to generate. There is also a plasma wakefield acceleration, which collectively accelerates a wave of charged particles.

The gradually decreasing tapered surface of the metal tip generates polariton wave transients (besides other effects), which have an electric field amplitude increasing with time along its path toward the tip. These electric fields might be high enough to generate a number of neutrons via the $p + e^* \rightarrow n + \nu$ (Widom-Larsen type) process, where e^* is a wave of surface or volumetric electrons, a plasmon polariton, a virtual particle of high-effective mass. It is not clear yet whether the Shoulders process can be used for any direct technical application, but it is home to a number of fundamentally important pseudo-particle processes of extreme amplitude. No wonder it yields the high mass particle clusters, perhaps poly-neutrons, detected elsewhere by John Fisher and Richard Oriani (see *Infinite Energy* #94). The phenomenon is sensitive to pressure and gas quality. A similar process takes places in a less intense manner on the surface of thin deuterated nickel wires during high current transients. The tapered, conical pins are a sort of geometrical field intensity amplifier, yielding an unbeatable advantage of simplicity over other methods.

Because this experimental method is inexpensive, even graduate students can work on it as truly fundamental research. However, it is very difficult to make a mathematical model of the interaction of the needle and the metal surface plasmon-polariton with the transient plasma.

The subject of "fusion by needles" also appears in an off mainstream D - T thermonuclear process developed by E.G. Bakhoum ("Very Small Scale Electrostatic-Confinement Fusion Apparatus," *IEEE Transactions on Plasma Science*, 37, October 2009, 2090-2097). The device, shown schematically in Figures 6a-b, successfully exceeded the ignition threshold near the tips; *i.e.* the product, plasma density · confinement time · kinetic energy exceeds $1.5 \cdot 10^{19}$ keV·sec/m^3. The needles are driven intermittently by a 100 kV power supply. Near the needle tips, the above triple product is about 10^{23} keV·sec/m^3, exceeding the break even condition, which has not been reached by other mainstream thermonuclear devices. This line of research has not been continued despite its merits. In my opinion this is the only good technical solution for the thermonuclear D - T process, which is oth-

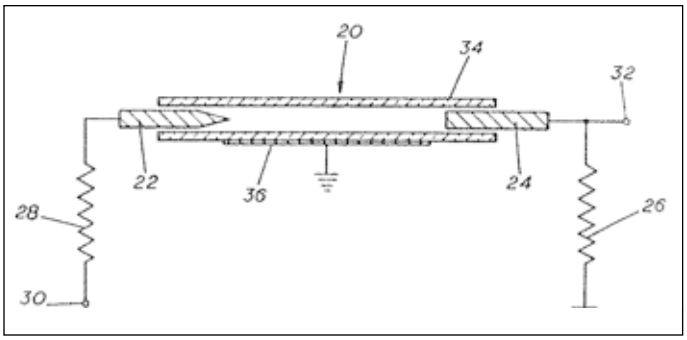

Figure 5. Shoulders' device in a patent figure.

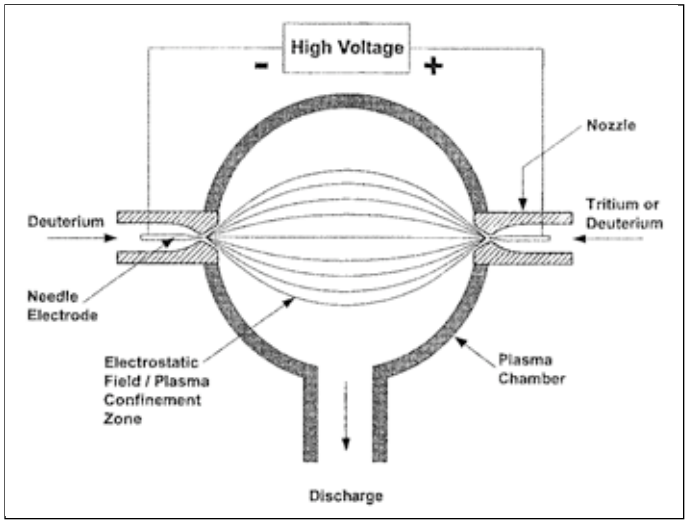

Figure 6a. E.G. Bakhoum's thermonuclear reactor concept built and successfully tested.

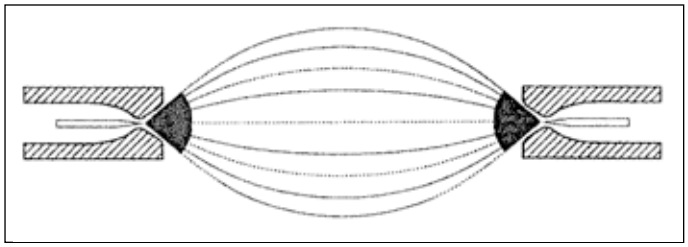

Figure 6b. The shaded area notes the region of ignition.

erwise faulty.

The useful nature of needles and cracks popped up by accident, as illustrated in other inventions described below.

Chernetsky – Plasmon Polaritons on Tapered Tips

Tapered, very sharp needles appear in four more discoveries. The first belongs to the renowned Russian plasma physicist, Alexander Chernetsky. The second belongs to the Canadian couple Alexandra and Paulo Correa. Both of them stumbled onto the excess energy generation by accident; both of them have published extensively about their discoveries; both have theorized extensively about the nature of their excess energy generation. According to this author both of them have missed the point, even the important aspects of the know-how.

Chernetsky used a low pressure, high frequency arc discharge to drive hydrogen plasma, which drove an inductively coupled circuit to the load. His sealed discharge tubes had symmetric circular molybdenum electrodes 0.8 cm in diameter. The current density had to reach a critical value, and it took several thousands of initial short arc pulses to "roughen up" the surface electrodes. His tubes had an inter-electrode volume of less than 1 cm^3. Otherwise the excess energy effect in the form of short, microsecond bursts did not appear.

In these tubes, hydrogen pressure is regulated by a getter, heated from an outside power source.

Chernetsky had a severe cathode erosion problem and his excess energy generation range of parameters was narrow.

He developed and demonstrated several devices, but he was a "heretic," and all his funds were cut off at the time of the collapse of the USSR. Though he teamed up with Andrei Sakharov, they missed the point. Sakharov suspected a vacuum energy fluctuation behind the voltage peaks, and bursts of excess energy. Chernetsky, a plasma theorist himself, worked hard with the equations of transient plasma oscillations, and derived the appearance of excess energy. However, he arbitrarily tampered with the signs of some terms to get the desired excess energy results.

But the real problem was the "fragility" of the tests results, like those of the early Pons-Fleischmann experiments. He published six papers (with colleagues Lichnikov and Popov) in Russian scientific journals, but after his death, his close associates did not continue this work.

Correa – Plasmon Polaritons on Needle Tips

The Correas stumbled onto this excess energy generation phenomena while clearing the surface of large, flat aluminum plates, in an argon atmosphere, using transient current impulses in abnormal glow → arc discharge transitions. The arc part should be cut as short as possible, because it hampers the phenomenon. The Correas have a wide patent portfolio, with extensive descriptions (see U.S. Patent 5,449,989/1995, or *Infinite Energy* #7 and #41).

This author has ten years of full time experience with both setups, extensive know-how and bitter disappointment with both approaches.

The most important and neglected feature of both effects has been the formation of very sharp tapered needles of nearly perfectly cylindrical symmetry on the cathodes. The formation of these needles deserves a separate research paper, because according to our knowledge of classical electrodynamics, they should not form. In the absence of these sharp needles, the sharp bursts generating current *cease altogether* when all the other conditions are the same. The molybdenum "needles" of Chernetsky's setup arise after hundreds of "roughening" current pulses. Tens of thousands of initial pulses are needed for the large area Correa cathodes (usually 64 cm^2). When the author tried an artificial grid of needles (spaced 0.5 - 1 mm apart with molybdenum needles, sharp blades, stainless steel mesh and brush), the bursts appeared immediately, but at lower voltage and current amplitudes. Higher current impulses quickly melted them. This technical nightmare of surface quality control made the author abandon the project, apart from personnel and financial difficulties.

Both Chernetsky and the Correas missed the importance of acoustic resonance. The excess energy released from a number of sharp metal tips, due to the apparent surface plasmon resonance, charge shielding and consequent fusion phenomena, was not efficiently coupled to the plasma. Consequently, the electric circuits extracting power did not work efficiently, though both of them desperately fought with this problem. The Correas even missed the importance of hydrogen as a fuel, though they (and we) noted that removing most of the water from the gas tube walls by baking them out reduces the extent of the effect, or ceases altogether.

All in all, the multiple needles on the electrodes are of major importance, and the effect has appeared and depended on the quality of the cathode surface, and not on the positive column or on the sharp electric gradient of the Faraday dark space as Chernetsky surmised.

The Correas tried small surface wire cathodes as well, with a higher electric field density, but in vain. The correlation between excess energy due to the cathode surface (needles), hydrogen gas and transient plasma discharges were beyond doubt. Certainly D_2 gas should have been looked at, but the lack of clear, reliable test results has prevented it. However, knowing the neutron generation capability of a high effective mass, high charge screening of surface plasmons and phonons, it is not a straightforward conclusion that only D gas or a D - T mixture can yield high outputs. Though a nuclear reaction can be just one of a number of possible and plausible models, it is a much cheaper testing ground than confinement-based hot fusion experiments.

This was the first series of events, when a correlation was found between the sharpness and number of needles, and craters with excess energy. The direction of excess current was also correlated with the location of the needles, or sharp-edged ring-shaped "craters."

A stereo microscope with a 50 power magnification was enough to observe the shape of the "moon-like" surface of the roughened electrodes. The Correas' device produced unusually shaped arc discharges, spherical near the cathode, conical towards the anode.

These phenomena have been marred by a number of "unknown unknowns." Therefore progress is inevitably slow and erratic if there is any at all (see Figures 7a-d).

Puharich, Meyer, Horvath – Plasmon Polaritons on Surface Protrusions in Ordinary Water

There are some light water inventions involving LENR. There is a third and fourth version of the "sharp needle on

the cathode," albeit a more elusive one. Andrija Puharich (U.S. Patent 4,394,230/1983) and Stan Meyer used ordinary, room temperature tap water for electrolysis, but not with DC. They used high voltage, low current resonant driving electric circuits to obtain oxy-gas at excess energy levels. Meyer demonstrated his inventions on video several times. He did not disclose enough details in his series of patents to make a device that could be successfully repeated. Most probably he was unable to control the surface quality, and was not even aware where the energy was coming from.

Meyer was the archetype of secretive, paranoid and arrogant inventor, who was his own worst enemy. He died in a restaurant, exclaiming that he was poisoned, and then was duly forgotten. His invention is considered a hoax today by most (see U.S. Patent 4,936,961/1990).

Meyer's resonant "tap water splitter" is a simpler version of the Chernetsky-Correa invention, provided the cathode was properly roughened in two ways. It might have had several micron-sized hydrogen filled cavities as a site of the surface plasmon polaritons and/or a multitude of sharp needles or blade-like protrusions or dendrides serving the same purpose. Stainless steel containing nickel is a catalyst for splitting H_2 molecules, but "naked protons" were also generated during the ordinary electrolysis of the water.

Again the surface quality of the cathode is of immense importance, but invisible to the naked eye. Its proper preparation is not just "know-how," but the very essence of the invention. Without disclosing enough details to be repeatable by those "skilled in the art," these patents are worthless and should not have been granted.

Stainless steel can be etched with different acids and/or it can be treated by a high pressure arc discharge to "roughen up" the cathode surface to make grooves, cracks or needle-like protrusions, so when they are covered by small bubbles and inside them there is hydrogen plasma, the same "nuclear active environment" is generated as in the above Correa and Chernetsky devices. Even an indirect $p^+ + Ni \rightarrow Cu$ process may take place, like those described by Scaramuzzi, Piantelli, Rossi and Preparata.

Yet another version of a Ni-H electrolysis cell was made by the Australian (Hungarian born) Stephen Horváth. He went one step further than Meyer, having the cathode—a magnetizable stainless steel alloy—driven into magnetostrictive resonance. Magnetostriction is especially strong in Ni and some Ni alloys, and it is a simple way to generate phonons, and volumetric pressure waves, in the metal lattice. In case of a fine tuned resonance, when the frequency of exciting mag-

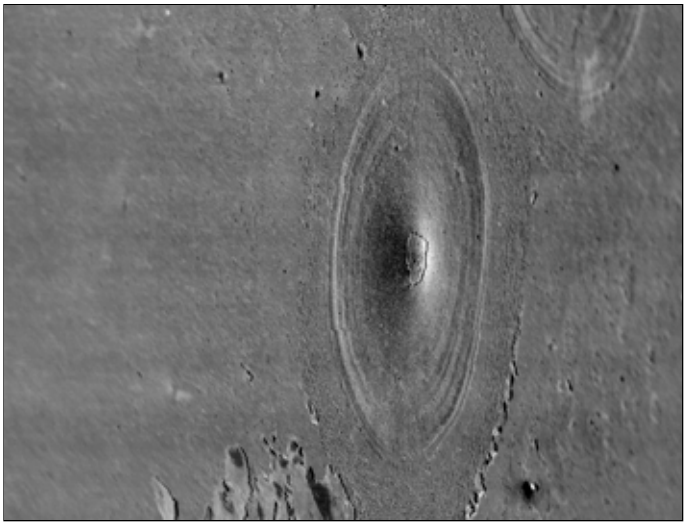

Figure 7a. The base of a sharp needle grown on the molybdenum cathode (broken during transportation).

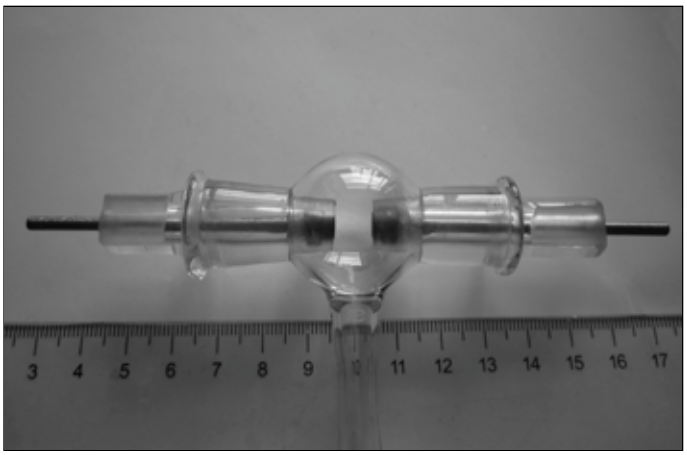

Figure 7b. A spherical Chernetsky tube with 8 mm diameter molybdenum electrodes. These electrodes are removable.

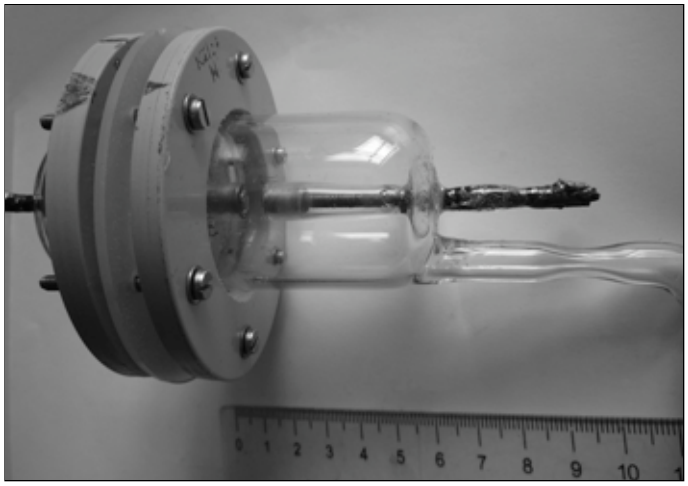

Figure 7c. Another Chernetsky tube, the same 8 mm diameter electrodes, but different shape of tube. There is no acoustic plasma resonance in this case.

Figure 7d. The author standing next to a Chernetsky-Correa test stand.

netic fields is the same as the mechanical vibration frequency of the cathode piece, the excitation energy is small and the process is efficient. Though these details are barely touched upon in his patent (U.S. Patent 3,980,053/1976), two of his investors, the Canadian-Hungarian Bela Kajdocsy and Mo Goldhaber spoke about it to the author, as part of the important know-how. A further useful feature of his cathode was that it had sharp edges to increase local electric fields, and to enlarge the surface of the cathode. This feature can be incorporated in electrolytic cathode designs, which are usually cylindrical or flat (except the Patterson cell).

However, the stainless steel (Ni-Fe-Cr alloy) is not ideal for bulk hydrogen loading, so most of the useful effects took place near the surface. Horváth, and some other technicians who tried to build his device, stumbled onto the usual effect. After some initial success, the excess energy disappeared.

Lacking a thorough understanding, and wasting money (ruining the investors), Horváth gave up this line of design. He now works on artificial muon induced fusion in Australia, to be discussed in Part 2.

There is a further version of the ordinary hydrogen loaded, Ni-alloy tube geometry electrolytic process, the "Joe cell." It is supposed to have resonant electric circuits for high frequency, high voltage excitation of the cathode. There are several embedded electrolytic tubular cells of carefully matched diameters and lengths. There are alkaline and acidic versions, and even pH neutral ones, like the Meyer cell. The Joe cell is the "layman's cold fusion" device. However, "cosmic energy" or "orgone energy" is mentioned as an energy source. No reliable, well-documented or repeatable experiments exist. The author is aware of some successful devices. They have performed well for a few days at the beginning and then suddenly turn into a highly wasteful cell, producing lots of ohmic losses and a brownish sludge on the cathode surface, apparently iron.

Phonons – Polaritons Inside Metal Hydrides

Phonons and plasmon polaritons are explicitly mentioned in the patent application of Robert E. Godes (2007/0206715) of Brillouin Technologies. The hydrogen loaded metal lattice is vibrated with ultrasound to induce lattice vibrations. The resulting added electron density waves are phonons, and pseudo-particles, which screen the charge of lattice hydrogen isotopes embedded in the cathode metal lattice.

The process takes place through several steps: p → D → T by neutron formation and neutron absorption. The plasma-based process is not discussed in detail in the patent application so it cannot be built by those "skilled in the art." The Brillouin patent application contains reference to phonons, and current induced polaritons as well.

This author has successful "hands on" experience with two systems of pulsed current induced polariton pseudo-particles endorsed by the late Italian professor, Giuliano Preparata. Our first setup was based on the Patterson cell with a large surface, and small spherical beads. The second flat, copper-palladium-nickel cathode setup worked well, with sudden current pulses. The beads were useless, apparently due to low current density. Phonons and volumetric polaritons (current transients) have lower frequencies, usually in the ultrasound frequency range. Therefore they are less economic than infrared induced polaritons in the order of tera and peta hertz. Moreover, phonons and current wave-induced volumetric polaritons require input energy, and power supplies. Infrared radiation-induced surface plasmon polaritons may induce self-sustaining heat generation by the positive feedback process of infrared-induced polariton resonance → heat generation → nuclear neutron capture → heat generation → infrared radiation induced (surface) polariton resonance chain with a positive feedback.

This process, termed as "heat after death," has been observed many times in recent years, but its connection to charge shielding or neutron generating pseudo-particles was not clearly explained.

One may surmise that the Ni - H, process of the late U.S. inventor James Patterson, and later followers of the Italian school, such as Piantelli and Rossi (WO2010/058288, US2011/0005506), used the same process, though it was usually shrouded in secrecy and mystery.

Esko, Egely – Dust Quasi-Particles

Not all the important work is hidden in secrecy and the fog of history. The important transmutation work of Ed Esko of Quantum Rabbit is well documented, and was published due to the existence of *Infinite Energy*. This work is based on a transient dusty plasma—arc discharge at low pressure without resonance. The cathode and anode consist of different metals, like copper or lead. The interesting feature is that they add different (pure) substances into the plasma chamber, like sulphur or lithium, and process them in a low pressure arc discharge. The result of these tests is a number of transmutation reactions, in the ppm range. Though these quantities are not yet in the commercial range, their scientific value is without any doubt; therefore they are duly ignored not only by the mainstream community (which is usual), but also by the small LENR community (which is sad). The Quantum Rabbit experiments were carefully documented. The test results were carefully measured with due scientific diligence, and the transmutation test results are far beyond the test error. Their main problem is that the test results are in irreconcilable contradiction to what mainstream physics teaches about the penetration of the Coulomb barrier.

There are some other inventions which can be related to LENR. The cavitation based (sonofusion) method of James Griggs is one example, but the hard data is so scarce, that there are question marks. Another candidate can be Casimir forces during bubble formation and collapse, but both phenomena can act simultaneously.

There are other similar "iffy" forgotten mysterious inventions in the field of "crypto technology," but less documented, therefore their evaluation would be very speculative.

There is another process and device fully disclosed by this author, based on resonant carbon nanodust plasma; see Figure 8 (and also *Infinite Energy* #102, video details: www.greentechinfo.eu).

Dust of Nature – Lightning

Mother Nature also provides some "freak" phenomena—slow neutron generation by lightning. These effects were independently noted by Brazilian, Indian and Russian researchers. The challenge is again, that according to the current mainstream wisdom, the usual 20 kV potential difference is simply not enough to create thermal neutrons; at least 0.7 MeV is needed. Lightning is considered an arc dis-

charge, albeit a transient one. Instead, lightning is really a series of short current bursts or waves, which take place in a dusty environment, in ground-to-air discharges.

Geophysical Anomalies

There are some other geophysical anomalies awaiting explanation. There are unusually large concentrations of some noble metals on Earth like gold, platinum and silver. Why? These deposits cannot just form by some biological or volcanic process. In fact, they should be evenly distributed in the crust of Earth, like rare earth materials. In reality, rare earth materials are not rare at all just evenly distributed in a diluted density, as they were formed during some age old supernova eruptions. Thus the mountains of silver or other precious metals had to be literally "manufactured on the spot" where they were found and mined.

Ball lightning is sometimes considered as a candidate for a "natural cold fusion reactor." Indeed, it sometimes has an unusually long lifetime (up to even a minute) and very high thermal and electric output. The boiling off 10 - 20 liters of water from a bath tube, evaporating 1 - 2 kg copper or aluminium electric wires from walls or lifting off massive roofs from buildings shows that it has extremely high energy.

The author has spent several years with fieldwork collecting eyewitness reports and shooting documentary films about the absolutely curious damage patterns caused by ball lightnings, partly as a consultant to insurance companies. There are more than 500 written observations (in English) and eight hours of uncut video recording on our website, www.greentechinfo.eu. Based on this database and those collected by other field investigators, my opinion is that the primary mechanism of ball lightning has no relation to nuclear phenomena, whether it is "hot" or low energy. All LENR devices need some sort of carefully designed engineering hardware. The LENR process will not be sustained out of thin air, as ball lightning is.

As ball lightning occurs in nature, it cannot be described by present mainstream physics in classical or quantum models. There are over 150 theoretical models which attempt to describe it, but each of them has very severe shortcomings. The worst feature is that it cannot be created artificially, only something disappointingly, distantly similar to it.

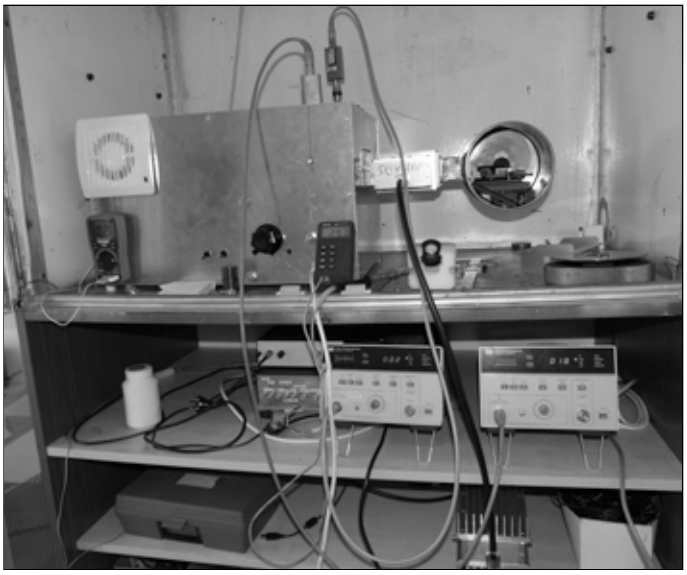

Figure 8. A carbon dust reactor of the author. The metal cylinder is the microwave resonator. There is a circulator between the waveguide and the resonant cylinder.

Interstellar Dust

It has been known since 1973 that 13 elements—O, Ne, Mg, Si, Ca, Ti, Kr, Sr, Te, Xe, Ba, Na and Sm—have a different isotope ratio depending on their source: the Earth's crust, solar or interstellar dust and materials. This shows that these elements are "manufactured" by different natural nuclear methods, even in cold interstellar dust.

There are similar problems with the synthesis of light elements, Li, Be, and B. Their abundance is higher in interstellar dust then in the solar system.

Polaritons in Biology?

Biological transmutation is perhaps the least-known and most ignored LENR phenomena. Due to the pioneering work of Louis Kervran, Vladimir Vysotskii and Alla Kornilova, the test results are compelling. The usual energy level (0.1 - 1 eV) of biological processes is hopelessly below the energy level of heavy ion collisions, where the formation of iron is observed:

> . . .an Englishman, William Prout, made a systematic study of the variations in calcium in incubating chicken eggs and found that when chicks hatched they contained four times more lime than was originally present in the egg and that, furthermore, the lime content of the shell had not changed. He concluded that there had to be an endogenous formation of lime from within the egg. This was long before scientists knew anything about the atom.
>
> Henri Spindler, a French scientist, became fascinated with how *Laminaria*, a variety of algae, seemed to be able to manufacture iodine. Searching for answers in half-forgotten literature on the dusty shelves of libraries, Spindler found that a German researcher by the name of Vogel had planted cress seeds in a container covered by a glass bell jar and fed them nothing but distilled water. A few months later when Vogel burned the adult plants, he found they contained twice the amount of sulfur which had been present in their seeds. Spindler also uncovered the fact that, soon after Vogel, two Britishers by the names of Lawes and Gilbert discovered at the famous Agricultural Research Institute at Rothamsted, England, that plants seemed to extract from the soil more elements than it contained.
>
> For seventeen years the Rothamsted researchers cropped a clover field, mowing it two or three times a year, and sowing it only every fourth year, without adding any fertilizer at all. This piece of land gave cuttings so abundant that it was estimated that if one had to add what had been removed in the period between the arrival of one swarm of seventeen-year locusts and another, it would be necessary to dump on the field over 5,700 pounds of lime, 2,700 pounds of magnesia, 4,700 pounds of potash, 2,700 pounds of phosphoric acid, and 5,700 pounds of nitrogen, or

more than ten tons of the products combined. Where had all these minerals come from?

Delving deeper into the mystery, Spindler came across the work of a Hanoverian baron, Albrecht von Herzeele, who, in 1873, brought out a revolutionary new book, *The Origin of Inorganic Substances*, which offered proof that, far from simply absorbing matter from the soil and the air, living plants are continuously creating matter. During his lifetime von Herzeele made hundreds of analysis indicating that, in seeds sprouting in distillated water, the original content of potash, phosphorus, magnesium, calcium, and sulfur quite inexplicably increased.

(From: *Alchemists in the Garden*, pp. 276-277)

Consequently either biological transmutation does not exist in nature, or some brand new phenomena may take place. Mainstream physics has the former opinion. This author has the opposite opinion. Therefore there is a need for an explanation.

Appendix: Polaritons, Plasmons

The usual definition of polaritons is described by several recent papers. They are charge waves propagating on the surface of a conductor. The definition applies to any conducting surface. Sometimes plasmons are used instead of polaritons, which is misleading. When there is a conducting plasma layer above the metal surface, a plasmon polariton is generated and we shall use this term.

Plasmons—the collective oscillations of conduction electrons in metals—are capable of confining electromagnetic energy down to deep sub-wavelengths. They can also enhance the intensity of an incident light wave by several orders of magnitude. These phenomena are the main reason why the field of plasmonics is finding a wide range of applications that include single-molecule sensing, non-linear optics, and optical trapping of nanometer sized objects. Recently confined plasmons have been observed and spatially mapped in doped graphene.

Electrostatic doping has actually been used to demonstrate plasmon frequency tunability and induced optical modulation in the TH_2 and infrared response of graphene.

(From: S. Thongrattanasiri, I. Silviero, F.J.G de Abajo. 2012. "Plasmons in Electrostatically Doped Graphene,"*Appl. Phys. Lett.*, 100, 201105)

It is an important feature of these surface electron oscillations that their resonant frequency can be influenced by the geometric features of surface irregularities, like their size and shape. See the following papers: M. Najiminaini *et al.* 2012. "Nano Hole Structure with Improved Surface Plasmon Energy Matching Characteristics," *Appl. Phys. Lett.*, 100, 043105, and J. Nin *et al.* 2012 "Graphene Induced Tunability of Surface Plasmon Resonance," *Appl. Phys. Lett.*, 100, 061116.

These papers reiterate the "strong confinement and enhancement of electric fields near the vicinity of conductive nanoparticles." Further, "plasmon resonance wavelength. . .tunability, to a desired wavelength is greatly beneficial. This can be achieved by controlling the size, the shape, the material of the nanoparticles and the dielectric constant of the surrounding media."

Though optical plasmon wave generation is usually conducted on noble metal surfaces in air, our range of interest is different. Instead of air, ordinary water or heavy water, or dilute plasma covers the metal surface. This adds a further effective mass to the electron waves. It is worth noting, that a different surface quality is necessary to resonate with ordinary or heavy hydrogen plasma, as described above. This might plausibly explain why some surfaces work only with light water, and other systems only with heavy water, provided their surface contains irregularities of uniform size. Reading these and dozens of similar related papers, the role of surface irregularities are of primary importance in controlling the complicated electron-plasma coupled waves. Further details will be discussed in Parts 2 and 3.

Plasmon polaritons concern us because they behave as heavy, charged quasi-particles of small size, highly compressed electron waves coupled to plasma containing hydrogen isotopes. Because a million of them can be compressed in a wave or in a charged dust particle, or on the tip of a tapered needle, they have a useful charge screening capability. Thus they can mitigate Coulomb repulsion, and consequently act like a catalyzer in some nuclear reactions.

Their application will be elucidated in Part 2 of this paper. The aim of this paper is to widen the scope of LENR modelling, as dominant theories were usually restricted to the technology of deuterated metal lattice. All the inventions/discoveries in this part use some forms of these particles.

Part 2 will appear in Issue 108.

Part 3 will appear in Issue 109.

About the Author

George Egely graduated from the Technical University of Budapest (1973). He worked at the Nuclear Energy Research Lab of the Hungarian Academy of Science from 1974 to 1990. He was a guest researcher at CISE (Italy) in 1977 for three months, and at Brookhaven National Lab (U.S.) in 1981-82 for 16 months. He received his Ph.D. in 1982, on the subject of nuclear accidents of pressurized water reactors. Egely has compiled a large collection of ball lightning observations by eyewitnesses, and published a couple of semi-popular books on this subject. He is the author of three textbooks on the physics of "lost or forgotten" effects and inventions, and of several semi-popular books on the same subjects (in Hungarian). Since 1990 he has been a team leader in several small projects in alternative technologies. Some videos of these tests are posted online: www.greentechinfo.eu

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