A Comparative Analysis about the Role of Lithium in A. Rossi's Patent, F. Piantelli's Patent and Open Power's Patent Application
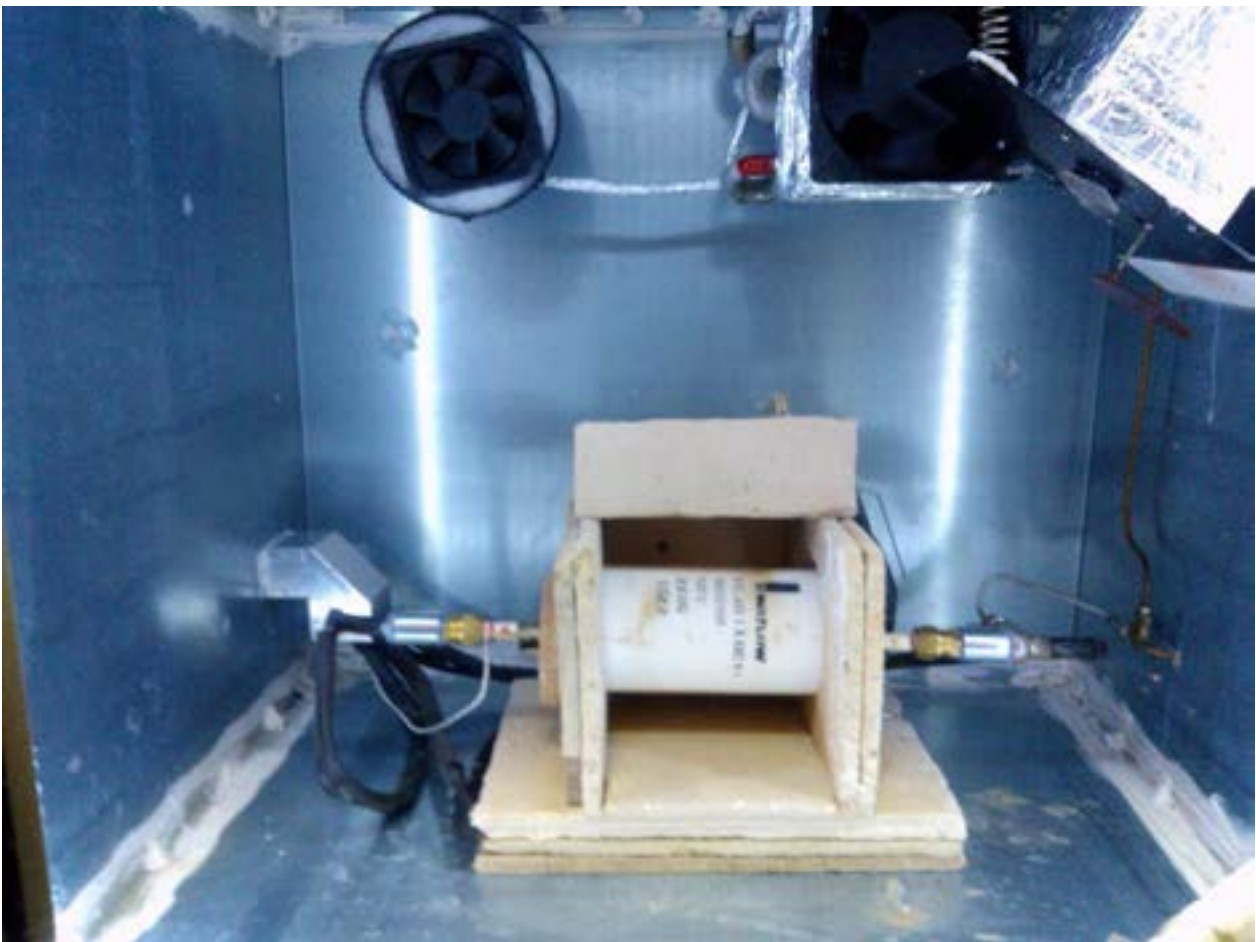

Fig. 1   Open Power's   *"Upgraded Parkhomov-like"*   Reactor in the Safety Chamber under temperature, pressure and webcam control (designed and assembled by Q. Cuccioli

Introduction

Recently, two important new patents were granted to Andrea Rossi and Francesco Piantelli, as an upgrading of their previous patents (see Appendix for more **important** details about chronological aspects, and a deeper insight into previous works , e.g. Reginald Little's)

See *A. Rossi* , US9115913b1**, Fluid heater:**
https://animpossibleinvention.files.wordpress.com/2015/08/us9115913b1.pdf

and *F.Piantelli* **,** WO2012147045A1**, Method and apparatus for generating energy by nuclear reactions of hydrogen adsorbed by orbital capture on a nanocrystalline structure of a metal**
http://www.google.com/patents/WO2012147045A1?hl=it&cl=zh

In the present report, a synthetic comparative analysis of the above mentioned patents will be drawn with respect to Open Power Patent Application, see:
http://www.hydrobetatron.org/files/20150306_Brev_Abundo_DEF_deposit_Pubb.pdf

Differences and analogies will be dealt with, from the *Lawson's Ignition Criteria* point of view.

For both patents, the formulation of a reaction model is well beyond the scope of present report, hence the following considerations must be considered only as a working hypothesis, to be intended not explicitly attributable to A.Rossi or F. Piantelli, or explicitly reported in their patents.

Aim of the report is, by comparing the three positions, to draw an experimental plan designed for enhancing our preliminary results discussed in previous communications:

http://www.hydrobetatron.org/files/Def_ICCF19_ABUNDO_Gen_Pubb.pdf

 and to assemble the corresponding setup suitable for trials.

The reading of a previous our introductory analysis about application of the mentioned ignition criteria is recommended:

 http://www.hydrobetatron.org/files/Lawson--Criteria_Pubb.pdf

 as well as our previous reports about the role of lithium in LENR, parts 1-2-3

http://www.hydrobetatron.org/files/02_Fusione-del-litio-dal-1932-e-ruolo-del-Li-nelle-LENR_7586o12h.pdf

http://www.hydrobetatron.org/014-report.html

http://www.hydrobetatron.org/015-report.html

Lithium, the lightest metal in the periodic table, is known to react, at high energies, both with neutrons and protons (respectively, Li^6 and Li^7 contained in the natural composition), to give an high output of energy related to the mass defect in the involved nuclear reactions (see mentioned patents).

The practical unavailability of such ignition energies, is avoided, both in Rossi's and Piantelli's patents, by different but intrinsically similar methods.

According to Lawson's criteria, an ultradense phase of reactants (hydrogen-hydrogen, deuterium-deuterium, deuterium-tritium, as far as hydrogen-lithium and so on) at nucleus-nucleus picometer distances, in a small compressed region of reactants, fed by localized energy in the nanosecond range, can react even at a low average energy, giving an exothermal nuclear fusion process.
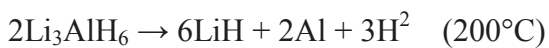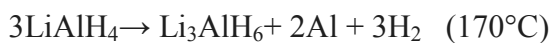
1. Rossi

In Rossi's patent, a mixture of micro to nano sized Ni, Li, $LiAlH_4$ is brought at high temperature (in the range 1000-1200 °C).

At standard pressure, lithium melts at about 180 °C, and boils at about 1340°C;

Ni melts at about 1450 °C; LiH (or LiD) melts at 690 °C and decomposes at 850 °C; Al melts at 660 °C and boils at about 2500 °C;

in the Rossi's conditions, LiAlH4 decomposes by the following *chemical* steps:

$$3LiAlH_4 \rightarrow Li_3AlH_6 + 2Al + 3H_2 \quad (170°C)$$

$$2Li_3AlH_6 \rightarrow 6LiH + 2Al + 3H^2 \quad (200°C)$$

$$2LiH + 2Al \leftrightarrow 2LiAl + H_2 \quad (400°C)$$

Because of the third reaction is *reversible*, the hydrogen pressure in the reaction chamber influences negatively the amount of LiH converted.

Thus, the overall balance between the evolved hydrogen from lithium hydrides and adsorbed one by nickel is of fundamental importance, suggesting to adopt an intimate contact between the two kinds of powders, as in Rossi's.
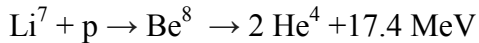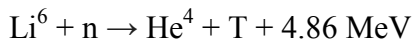
Finally, in the process operating conditions, nickel should be solid, lithium liquid and adsorbed on nickel as well as aluminum, hydrides partially decomposed, hydrogen gaseous and adsorbed (with a little percentage of lithium vapor, according to its vapor pressure).

Owing to the high porosity and related surface area (and its specific capability) of nickel powder, liquid lithium and aluminum, and gaseous hydrogen are strongly adsorbed in the lattice, in intimate contact each other. By admitting an ultradense phase, at nucleus-nucleus distances of picometers, Lawson's criteria *admit* nuclear fusion in presence of strong spatial and temporal local energy gradients.

Source of such gradients (*B.Ahern's energy localization*) may be (at high average temperature) the presence of time–dependant modifications of the heating field (and consequent temperature gradient), together with *thermoelectric* properties of the couples Li-Ni, Al-Ni, enhanced by variable magnetic fields induced by the special structure of the electric heater.

Owing to the high speed of the sound in liquid Li-Al system, shock waves may form too, causing implosions (reported in literature as causes of nuclear fusion in presence of hydrogen).

Some considerable reactions may be:

$Li^7 + n \rightarrow He^4 + T + n^* - 2.5$ MeV   n* = thermal neutron

$Li^6 + n \rightarrow He^4 + T + 4.86$ MeV

$Li^7 + p \rightarrow Be^8 \rightarrow 2\ He^4 + 17.4$ MeV

Protons are largely available, and *quasi-neutrons* may be formed by the shielding property of electron on nucleus at picometer nucleus-nucleus distance.

By an *original* hypothesis (at the extent known to the author), dealing with the chances of a masked proton to overcome the Coulomb barrier, the reaction equations may be written in a new *chemical-nuclear* form, as reported in **Ugo Abundo**, "Interpretation and enhancement of the excess energy of Rossi's reactor via Santilli neutroids and nucleoids", Hadronic Journal Vol. 37, pages 697-737 (2014) http://www.thunder-fusion.com/docs/abundo-paper-2014.pdf.

The above mentioned equations may be therefore responsible for the anomalous heat excess.
According to the presently discussed patent, nickel in an overall balace does not participate to the nuclear reactions, acting only as a *catalyst* to promote them.
On the other hand, from previous "Lugano report" (lower lithium presence) we know the nickel isotopic composition shifts, by subsequent transmutations leading to copper.
Probably, in the strong presence of lithium, nickel experiences only minor side reactions.

2. Piantelli

In Piantelli's patent, the reactor shows a more complex structure, consisting in a nickel core, surrounded by a lithium or boron-based region.

Regardless of the core metal is nanosized as in Rossi's (here clustered) , Ni and Li (or boron) are confined in different regions, and not in intimate contact.
Admittedly, the energy output benefits from two different contributes: the Ni-H fusion (perhaps some H-H fusion) in the inner core, and the proton-lithium (or boron) interactions, in the outer area.

According to F.Piantelli, a strong excitation, under the form of electric pulses (or laser), is fed to the nanosized nickel core, structured in clusters of a few atoms, obtained by suitable processes.

Gaseous molecular hydrogen, ionized in the form H^+ and H^- by the solicitation, is brought in contact with the nickel lattice, and pushed (compressed) towards adsorbed one on the metal surface. The anharmonic conditions of high energy localization, owing to the particular geometrical nanostructure, promotes some captures of H^- and some scattering of H^+.

The captured H generates primary energy; the scattered protons are able to be subsequently intercepted by surrounding Li^7 (or boron) and perhaps, in the masked quasi-neutron form , by Li^6, by an exothermal fusion process, with a further secondary contribution to energy yeld.

This frame shows the different use of lithium in the two patents: shortly, in Rossi's, H-Li interaction is thought as the principal reaction; in Piantelli's, Ni-H interaction (perhaps some H-H interactions) is the first step for a secondary proton (perhaps quasi-neutron too) capture by lithium or boron nuclei.

Some suggested equations are:

$Ni^{58} + p \rightarrow Cu^{59} + 3.4$ MeV

$Ni^{60} + p \rightarrow Cu^{61} + 4.8$ MeV

$B^{11} + p \rightarrow C^{12} + 16$ Mev
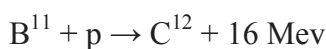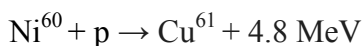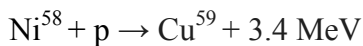
(together with an exothermal shift of atomic weight of Ni in case of quasi-neutron capture).

The required *Lawson's conditions* are here provided both by high density of adsorbed hydrogen and pulsed solicitations (together with temperature gradient) in the particular nanocluster-shaped structure.

3. Open Power

In Open Power's patent application, ***originally and independently written*** before the publication of Rossi's and Piantelli's ones, the respective solutions **appear anticipated** in a *synergistic way* : lithium and nickel **mixed** as in Rossi's **and** electrically **solicited** as in Piantelli's.

We will here highlight only the main features.

By adopting a highly impulsive electric solicitation , driven by tens of Kilovolts between the electrodes, with a narrow waveform, wide only tens of nanoseconds (enhancement of Piantelli's), the *Lawson criteria* need both a suitable fuel, and a high local concentration of reactants and energy.

It must be underlined that the low repetition rate of the pulsed waveform assures a low input power demand.

In the nickel highly porous core, lithium **and boron** fuels are intimately mixed in nanosize powder in the presence of **iron** as a molecular hydrogen splitter (enhancement of Rossi's).

Although the core may be suitably constituted of a dehydrogenation catalyst (iron oxide doped with alkaline metals, as in L.Holmlid, see our previous reports), we recognize the Ni-Fe well known dehydrogenation catalyst, as likewise suitable.

A variable composition of hydrogen and deuterium (fed in the reaction chamber under pressure, or internally generated by thermal decomposition of hydrides and deuterides), supplies protons and neutrons to **all** the same reactions above reported **overally** in the previous paragraphs **1.** and **2.** updated with **:**

$D + T \rightarrow He^4 + n + 17.5$ MeV   (Tritium eventually generated by $n + Li^6$ may react with D)

$Li^6 + D \rightarrow 2 He^4 + 22.4$ MeV

Lithium may be introduced in the core also in the form of ions, evolved by heating some minerals as *Spodumene*, a litium aluminum silicate that decomposes at about 960 °C, as reported in *R. L. Hirsch*, US Patent 3533910, **Lithium ion source in apparatus for generating fusion reactions**, http://www.google.com.ar/patents/US3533910 and accelerated by the high electric field towards the cathodic powders.

Local **thermoelectric** effects between Ni-Fe and Ni-Li couples, **piezoelectric** ones owing to the presence of boron carbide, **implosions** in liquid lithium (high sound speed) from shockwaves, arise from pulsed solicitations in the nanosized material, promoting *B. Ahern's energy localization*, to achieve locally the ignition thresholds for nuclear fusion reactions.

The special radial reactor shape (in some embodiments) achieves a high compression factor on ionized light elements (hydrogen isotopes and/or lithium, if supplied in the gas composition), to be thrown towards the nickel porous cathodic target, and there electrically compressed by electric gradient.

The comparison between some drawings in Piantelli's and Open Power's design is very impressive.
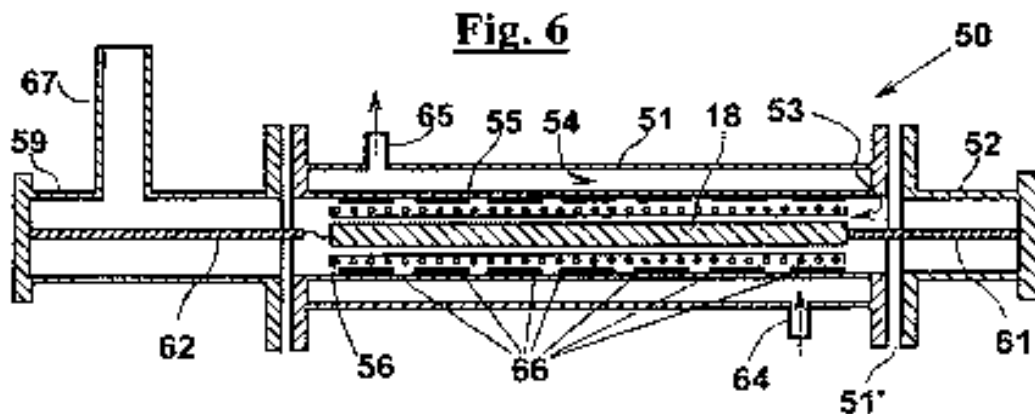

Fig.2   Layout of Piantelli's reactor (from cited Patent)
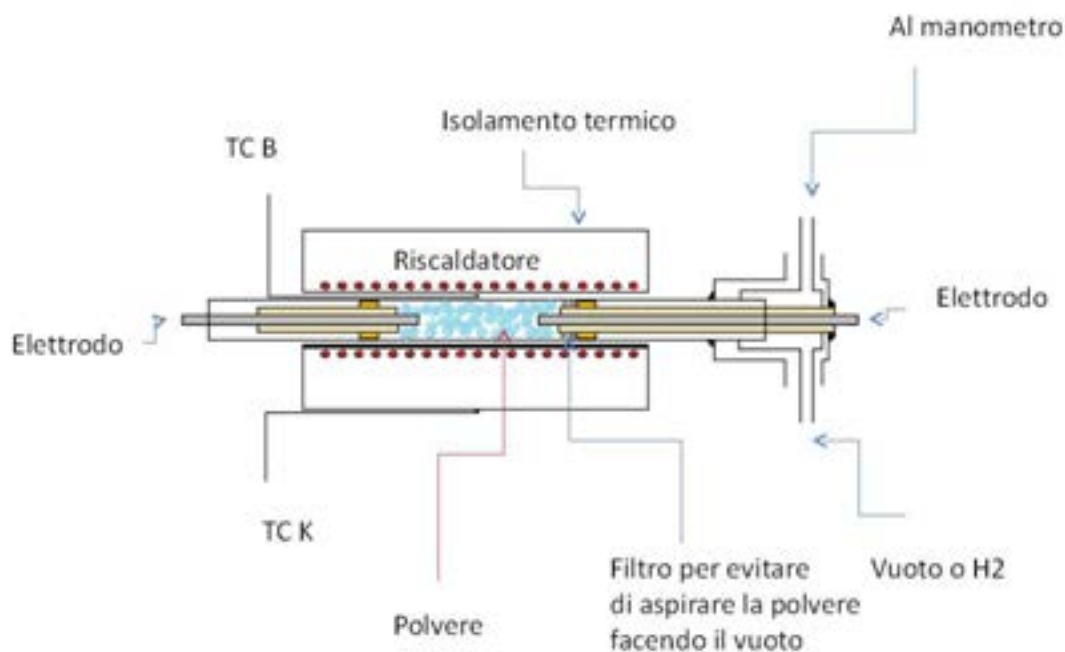

Fig.3 Layout of a reactor of Open Power's ones   (*"Upgraded Parkhomov-like"*)   as revised

by U. Mastromatteo

As since our introduction, we wish now to draw an experimental plan designed for enhancing our preliminary results , with the corresponding setup suitable for trials.

The reactants will be encapsulated, to be introduced both in the so called *Pulsed Linear Reactor* and *Parkhomov-like* one.
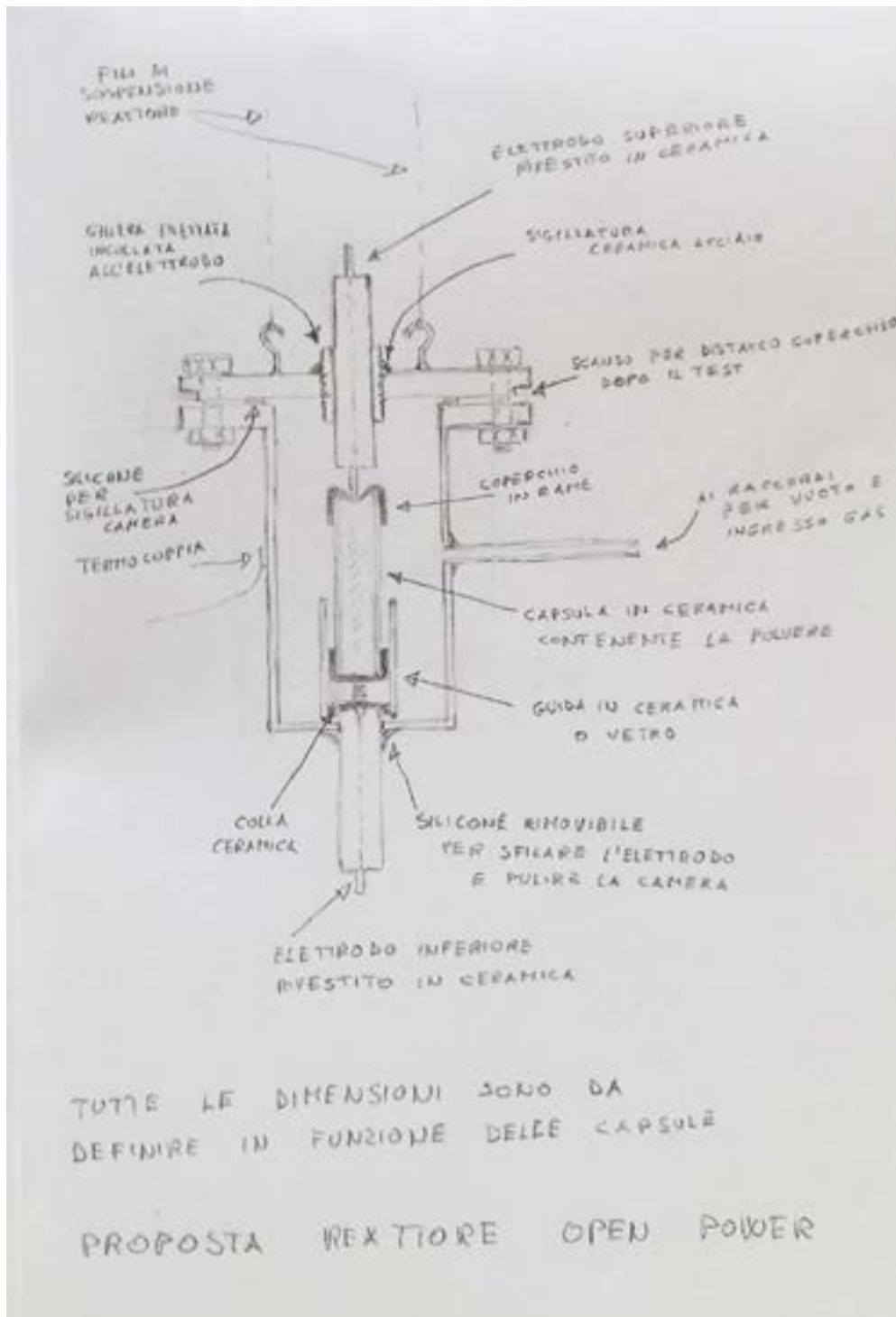

Fig.4   Open Power's *Pulsed Linear Reactor*, **as recently revised by** *U. Mastromatteo*

Each branch of the experimentation has an own characterization, to search the optimum ratio between disordered energy input and ordered one:

in the Pulsed Linear Reactor, the fuel will be solicited at low-medium temperature, and high electric power;

in the Parkhomov-like, it will be solicited at high temperature, and low-medium electric power;

in both cases, neutrons will be searched for.

4. Martin Fleischmann Memorial Project

According to the cooperation between Open Power and MFMP, an experimentation inspired to Parkhomov's one is actually under development, in an **enhanced form**, by the presence of electrodes in the reactor.

A preliminary plan of the first encapsulated fuel compositions is the following:

a) 1g Ni nanopowder (under hydrogen in the reactor)
b) 0.1 g LiAlH4
c) 1g W micrometric powder (as reference)
d) 0.5 g Ni nano/ 0.5 g Fe nano
e) 1 g Ni nano / 0.1 g LiAlH4
f) 0.5 g Ni nano/ 0.5 g Fe nano/ 0.1 g LiAlH4
g) 0.1 g LiD (about same protons as previous lithium aluminum hydride)
h) 1g Ni nano /0.1 g LiD
i) 0.5 g Ni nano/ 0.5 g Fe nano/ 0.1 g LiD ;

to avoid sintering and simultaneously introduce boron:

add 0.2 g B_4C to each one of preceding compositions.

The plan will be implemented according to the *Operative Protocols* (as revised by U.Mastromatteo):

http://www.hydrobetatron.org/files/Protocolli-aggiornato-15-09-2015.pdf

In the following, a photo-gallery of some particulars of the setup.

Fig.5 Reaction tube in the heater, in the safety box

Fig.6 Webcam in the safety box

Fig.7 Left electrode

Fig.8 Right electrode

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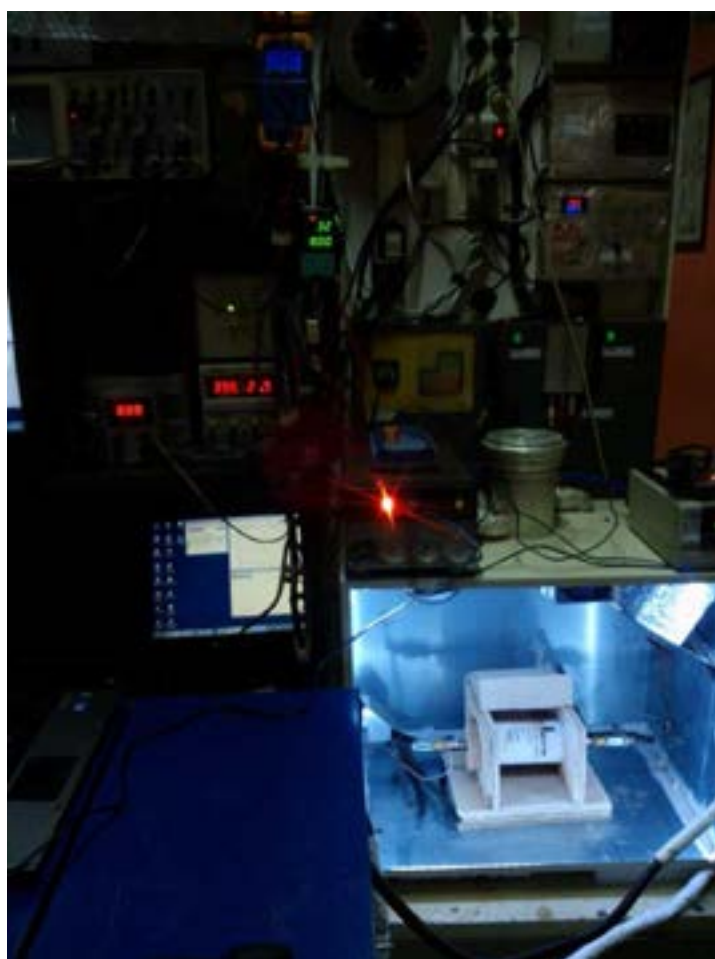
Fig.9 Overall view

Fig.10 Measuring devices and reactor (1)

Fig.11　Measuring devices and reactor (2)

Fig.12　Temperature and pressure control in the closed safety box

Fig.13 Reactor pressure control
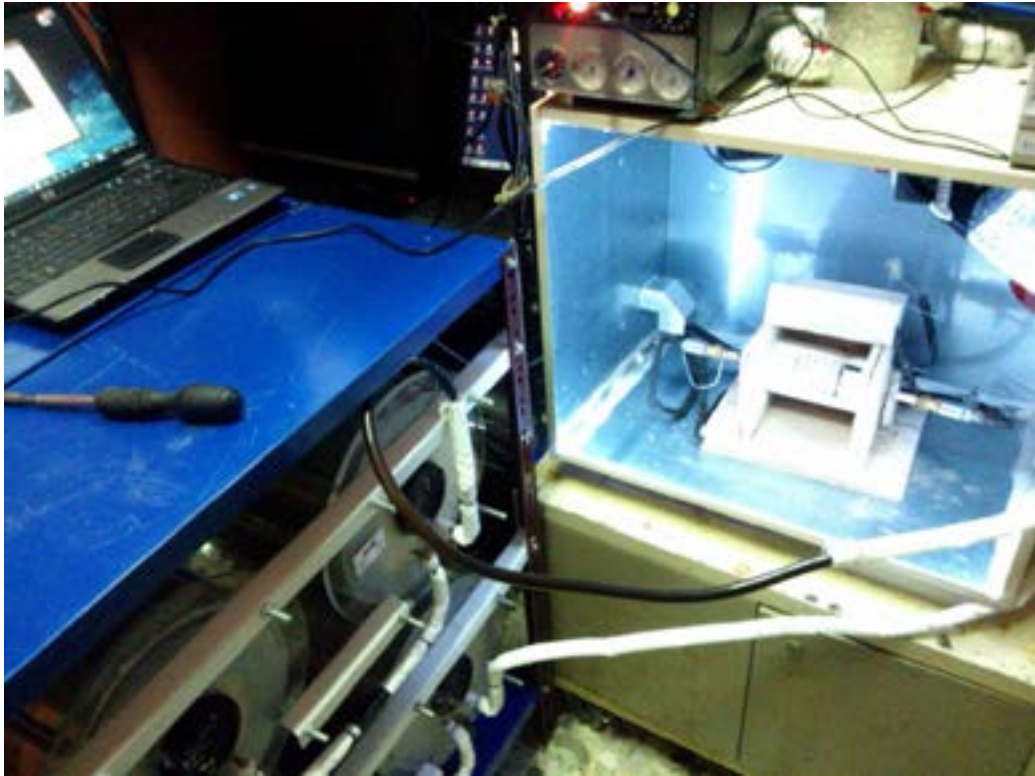

Fig.14   Reactor temperature recording
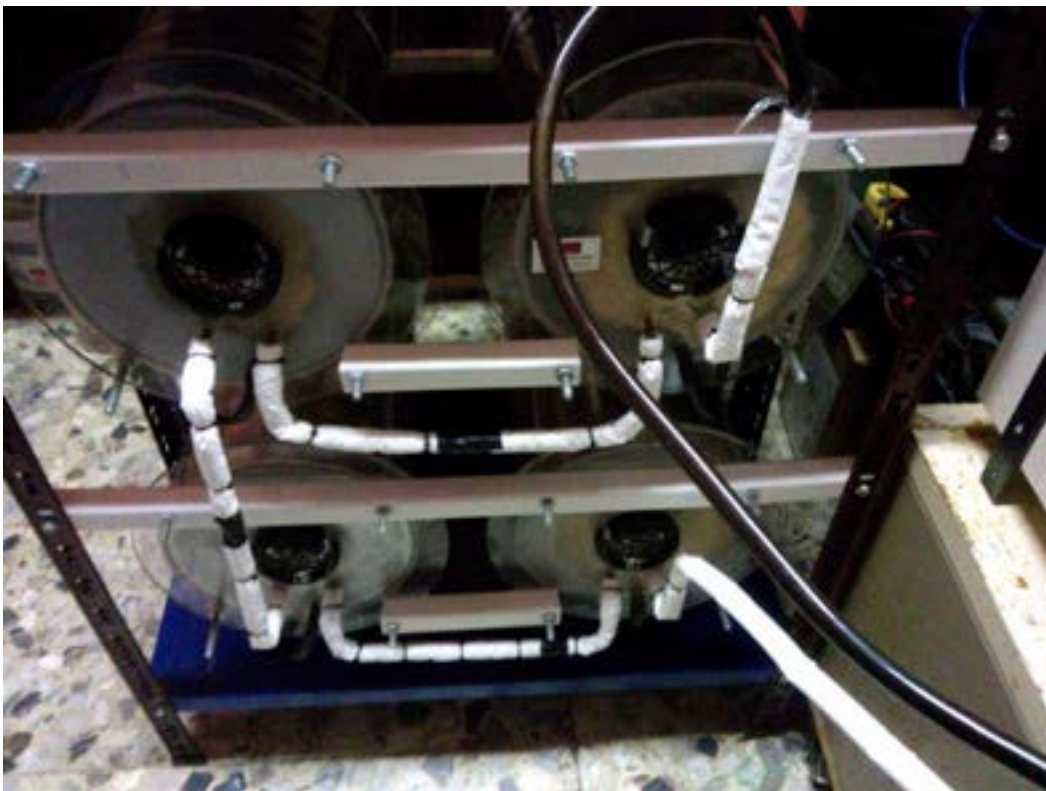
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Fig.15   Box refrigeration system

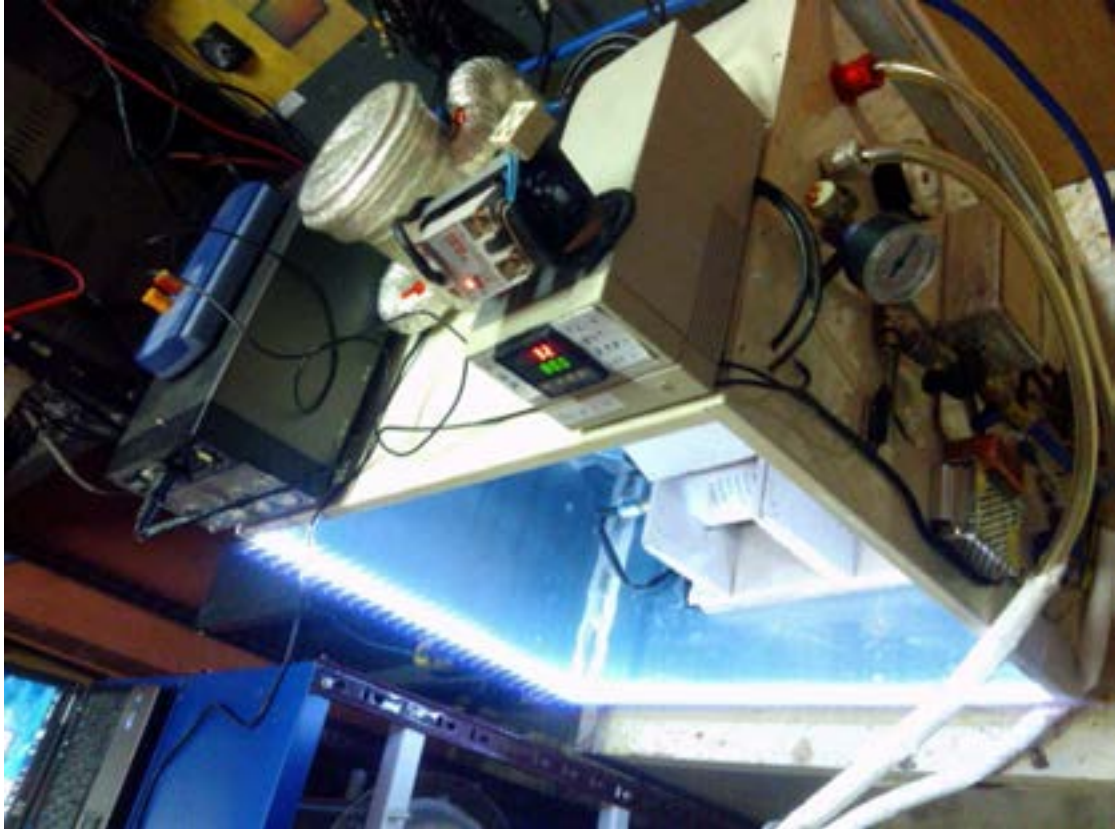**Fig.16 Box refrigeration system (particular)**

Fig.17   Safety Chamber temperature control

Appendix

Thanks to a private communication from courtesy of ***Bob Greenyer*** (MFMP) after a preview of the present report, we can add a link to one of his important writings in the field https://www.facebook.com/MartinFleischmannMemorialProject/posts/1035061893191176 and some precious insights about chronological aspects and previous works , e.g. Reginald Little's, by the words of the Author :

". 1. It by others is written that Piantelli during the early 1990s used Ni rather than Pd as Ni is cheaper and Ni is of the same family as Pd.

2. Piantelli's patent (filed April 26, 2011) (METHOD AND APPARATUS FOR GENERATING ENERGY BY NUCLEAR REACTIONS OF HYDROGEN ADSORBED BY ORBITAL CAPTURE ON A NANOCRYSTALLINE STRUCTURE OF A METAL) is not the first published mechanism of hydrogen (and hydride [H-]) absorbed into orbitals of a nanocrystal of a metal.

3. Such mechanism of of hydrogen (and hydride [H-]) absorbed into orbitals of a nanocrystal of a metal was first discovered, predicted and published in 2006: http://arxiv.org/abs/cond-mat/... ; and later published in IJPS (2006) [below * I will quote a paragraph that exactly and explicitly note such.]

4. Rossi has done outstanding in demonstrating new effects of Ni-H-Li since 2009.

5 Such Li-H-Ni system was not first disclosed by Rossi in 2009 or 2010.

16

6. But such system was first published in US patent application : http://www.google.com/patents/... ; (April 2005) wherein it explicitly notes and develops in details the ability of electric fields, magnetic fields, electromagnetic waves and pressure to stimulate ferro-metal lattices to excite electrons in magnetic field and with the build-up extending from valence to core electrons where by external species like hydrides can become involved and electrons in general excited outward from the core with anti-symmetry of the magnetic environment preventing relaxation and the build-up of energy of such ferrometal pycno-media intensifies the energy to nuclear energies in particular of nuclear energies of smaller isotopes such that if 'target atoms' (H, He, Li, Be, B, C, N , O) are present then the excited magnetized core ferrometal lattice can couple with nuclei of these target atoms like H and Li and drive and organize nuclear reactions therein.

7. In the two documents referenced here, it explicitly notes that during uptake of hydride into the valence and core of the atoms of metal lattices and nanoparticles the electrons can be stripped off the hydrides to leave neutrons and protons which can collapse on the nuclei and/or the electron and proton form neutron can collapse on nuclei as well. from http://arxiv.org/abs/cond-mat/0608071

"The mechanism based on magnetic orchestration of pycnonuclear reactions involves the following steps:

1.) under the prevailing conditions hydrogen uptake by the metal lattice and the high current density allow the formation of some amount of a hydride species (H-);

2.) the thermal and pressure fluctuations and magnetization cause the electronic rehybridization of the background Cu-Ag lattice with consequent sporadic localization and delocalization of these electrons and protons of hydride species (H-) within the Cu-Ag lattice;

3.) these protons and electrons of this hydride species exist delocalized in the 4d-like orbitals of the Cu-Ag lattice;

4.) localization of protons and electrons produces this hydride species in the metal lattice by the rehybridization of 3d, 4d, 4s, and 5s orbitals of the metal lattice;

5.) such localization by lattice rehybridization and confinement of H- within sd hybrid orbitals contribute to greater s character of the interacting electrons and protons in the form of (ea-p+eb-) or (hydride species) within the sd hybrid orbitals within the metal lattice;

6.) within the sd hybrid orbitals the (ea-p+eb-)with its net negative charge is strongly attracted in the localization to the nucleus (M47+) of the metal atoms within the lattice;

7.) the (ea-p+eb-) is heavier and more classical in its interactions with the nucleus;

8.) as the (ea-p+eb-) approaches the nucleus the ea- is driven into tighter orbital correlation with the p+ in order to shield the proton from the nearby nucleus (M47+) in this confined s orbital state for the local metal nuclear compression of the ea- and p+;

9.) the spin and magnetic properties of the confined (ea-p+eb-) state are more paramagnetic, an external magnetic field can therefore orients the nuclear spin of the metal atoms with the spin and orbital moments of the (ea-p+eb-);

10.) as the (ea-p+eb-) approaches the nucleus (M47+), the nuclear spin torques the eb- by nuclear spin-orbit interactions for its intersystem crossing, so eb- changes correlation with the (ea- - p+), thereby driving the ea- into the p+ for even tighter orbits, this orbital compression is strengthened by the huge nearby electric field of the metal nucleus within the s orbital of the metal atom;

11.) the resulting aligned spins of the metal nucleus (M47+) and the eb- organize the steering of ea- into collapse onto the p+ for reverse beta to form neutrons, eb- may also collapse onto the metal nucleus; the p+ may collapse onto metal nucleus; the resulting neutron may also collapse on the nucleus for various rare transmutation processes. See Table 7.

12.) the proximity (less than 0.5 Angstroms) of the ea- --- p+ to the eb- and the metal nucleus (M47+) within the s orbital allows huge local magnetic fields within the s orbital for extremely strong spin torque of ea- into the p+ thereby preventing gamma exchange as in isolated hydrogen thereby allowing the ea- --- p+ to form a neutron. It is within the s orbital with finite nonzero probability of the ea- --- p+ and eb- having very close proximity to the metal nucleus that length scales of <10-14 m are very small compared to larger atom size dimensions of >10-10 m such that the magnetic forces within the s orbital are on the order of 1/(10-5) 2 times the magnetic forces between lattice electrons in the

domain of say a ferrometal. The magnetic forces between lattice electrons in the domain of a ferrometal of Fe are on the order of 1000 tesla. So the magnetic forces between the e- and p+ and the metal nucleus for very close nuclear approach of the hydride species to the nucleus of a metal atoms is on the order of 1010 X 1000 tesla or 1013 tesla. Therefore within the s orbital of the metal lattice, the e- and p+ of the hydride species would locally experience tremendous magnetic fields on the order of the magnetic fields in magnetars. An external magnetic field organizes (as in this work) the (ea-p+eb-) and metal nuclei for more favorable weak interactions, leading to enhanced cross-sections for fusion events. In zero applied magnetic field, the proper spin and orbital orientations for such fusion processes are much more random and less likely. The important of such left-right symmetry during weak processes has been demonstrated by Yang and Lee [40]. Yang and Lee determined that within an external magnetic field, the nuclear spin oriented such that during the beta process the release of electron has specific momentum relative to the nucleus that released it. Here on the basis of the Little Effect, it is demonstrated that an external magnetic field can orient the e and nucleus for the reverse process of reverse beta for greater probability of such rare fusion events. The external magnetic field in this way organizes the spins for such symmetry for the reverse beta process and e- or p+ capture process by the metal nucleus for greater rates and reproducibility of the pycnonuclear reactions. Without the external magnetization, the cross-section and probability are much lower. Here these still slow nuclear processes within the strong magnetic environment, high current densities, Lorentz compression and thermal fluctuations are observed due to the long period of these conditions, more than 2000 hours. Although, the rates of pycnonuclear reactions are still very slow under the conditions within the strong magnet, even greater energy input via laser irradiation of the Cu-Ag matrix can promote much greater pycnonuclear fusion rates for future practical energy sources. Large magnetic field can build up huge potential energy due to Pauli antisymmetry with faster spin torque of electrons into protons for faster neutron formation (reverse beta processes) and neutron, electron and proton captures by Ag and Pd nuclei. The greater spin torque on orbital motion and the greater nuclear induced intersystem crossing also contribute more pycnonuclear phenomena in 4d relative to 3d transition metals in strong magnetic fields. **Reginald B. Little**"

Ugo Abundo at Open Power Association