The DeLuze Fusion Reactors

I am pleased to inform you that after more than 10 years of scrutiny, the U.S. patent office (USPTO) has granted me a patent on a hot hydrogen fusion nuclear reactor. As you know, it is very difficult to get a US patent on fusion. The first fusion reactor patent was granted in 1947 to Sir George Paget Thomson of Britain. My patent may be the most recent of very few issued patents on fusion. This invention is a unique and patented means of efficiently providing sustainable energy in significant amounts.

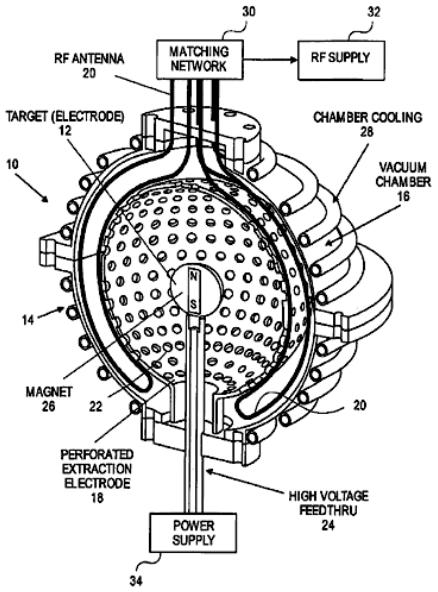
This reactor fuses hydrogen from water into helium. One pound of hydrogen from about one gallon of water produces the energy equivalent of burning 50,000 barrels of oil or 10,000 tons of coal. The only radioactive byproduct is tritium which can also be used as a fuel component to run the reactor. Other than the low level radiation of materials exposed to neutron flux, there will be no radioactive wastes. Carbon free, safe, environmentally friendly, unlimited energy for as long as we will need it.

This process is at the cutting edge of a technological pathway first disclosed by Brookhaven National Lab in New York and refined by Lawrence Livermore Lab in California. The Brookhaven Livermore approach terminates with a device capable of "flashing on" as a neutron source for a limited time which is used for instrumentation and imaging. The differences in my invention produce a device that is able to operate "continuously" as needed for power generation.

Dr. Leung of Lawrence Livermore Lab was granted US patent 7,139,349 B2 on Nov. 21, 2006.[1] My patent issued on 1/3/2012 as US 8,090,071 B2. The remaining new matter is pending as US application 13/317,838 filed 10/28/2011, document number 20120097532. Together the issued patent and divisional application present the clearest, most up to date, and complete write-up on this technology.

This technological approach was first described by Beuhler at Brookhaven National Lab. Described is a means of ionization followed by linear, DC particle acceleration to a titanium target using heavy water ice crystals. The researchers concluded that this research suggested the possibility of a new path to fusion power. [2]

Figure 1



Dr. Leung of Lawrence Livermore Lab disclosed a concentric variation, providing means of impacting a central spherical target with "beamlets" of DC accelerated ionized deuterium impacting the target in three dimensions, figure 1. This operational device appears to be an evolution of Beuhler's device in three dimensions, using deuterium instead of heavy water ice. It does not have outlet apertures and the beamlet focus is accomplished by perforations in the extraction electrode. Identically to Beuhler's device, the ion beams travel in one direction relative to the target. This variant has been proven operational and is used in instrumentation and imaging.

The next logical progressive step from Dr. Leung's device would be to use AC particle acceleration. That is exactly what I disclosed; a concentric variant using AC for particle acceleration. After ionization it functions similarly to Dr. Leung's device. It differs in that the ions accelerate to the central target as a collapsing sphere in a spherical version. Once assembly and ion impact occurs at or about the target surface, my invention becomes radically different. The AC acceleration potential continually reverses polarity. This periodically stops the fusion reactions, disassembles the reacting mass, and accelerates the ions peripherally resulting in the outward accelerating ions combining with incoming electrons forming neutral gas. This provides a time and place for the exchange of exhaust and fuel gases. This cyclic action repeats as long as the AC drive potential is present. This repetitive on off cycling gives controllability, stability, and a means of extracting waste and providing new fuel. It can operate continuously. [3]

The technological approach of my invention has already been proposed by Brookhaven and proven operational by the Lawrence Livermore. My prototype will be used to further advance this technological approach by permitting "continuous" operation. Additionally, catalytic gases will be provided to further facilitate these fusion reactions.

I have divided my reactors into two classifications: phase I and phase II. The shapes in each can be spheres, cylinders, toroids, coiled helixes, and so forth.

In phase I reactors, the target is a material substance such as titanium. The power limit of the reactor depends on the sustainable operational temperature of the target.

Phase II reactors have a virtual target. Reacting ions collide head on in an assembled mass of ions. This variant will fuse light hydrogen, mass number one. The power limit of the reactor depends on the sustainable operational temperature of the reactor's outer

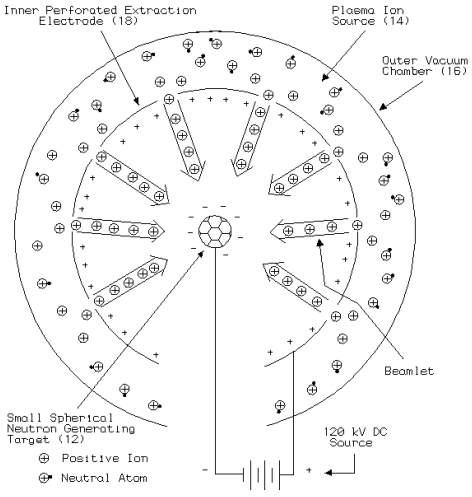
envelope. This envelope is at some distance from the reacting mass. These reactors can therefore operate at much higher power levels for a given reactor size.

Most radically, I have dismissed the Lawson Parameter, the confinement approach, and the concept of ignition. These processes do occur and are relevant to fusion reactions in stars. But we are not in a star and we can not efficiently reproduce those conditions here on earth in a manner to efficiently provide a primary fusion energy source. These considerations have been a huge stumbling block which has hindered the development of controlled fusion from the beginning.

Increases in temperature and pressure do lead to fusion. But they are not the direct determinants of fusion. Particle collision velocity only is that direct determinant. Temperature and pressure are secondary determinants in that they both increase particle velocity and the concomitant particle collision velocity. I reasoned, that if temperature and pressure are not the direct determinants of fusion, why not throw them out of the consideration. They will both increase in the presence of fusion, but let them take care of themselves. To efficiently use applied energy to produce fusion reactions here on earth, that energy must not be expended to increase temperature and pressure. That energy must be directed solely at increasing particle velocity and it's concomitant particle collision velocity. This is the key to efficient production and control of fusion reactions. This approach eliminates confinement and ignition processes from the equation. What remains is a particle accelerator.

Brookhaven Lab proposed this route in 1989. They conceived a linear, single axis, DC particle accelerator. Lawrence livermore subsequently developed and put into operation a radially and axially concentric DC particle accelerator.

Figure 2

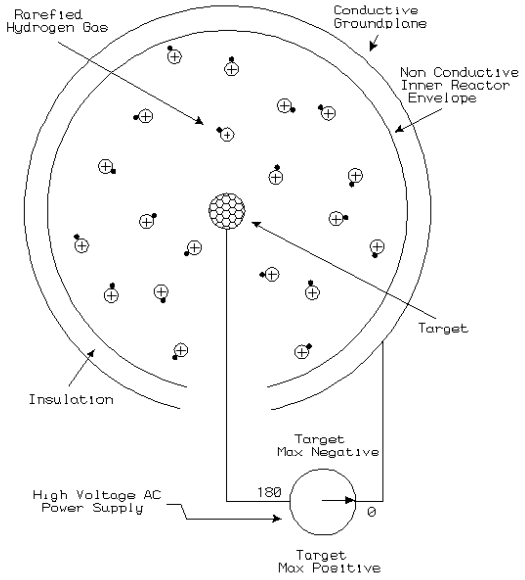


See Figure 2 which presents a conceptional cross section of the spherical neutron generator of Lawrence Livermore Lab. The parenthesized numbers correspond to the item numbers of the drawings in the issued patent. An outer vacuum chamber encloses a plasma ion source. This ion source encloses a perforated conductive metal extraction electrode in which is centered a small spherical target. The extraction electrode is the electrical ground plane of the particle acceleration component of this device. The central target electrode is biased at 120 kV negative DC potential with respect to this internal ground plane.

Positive ions formed within the ion source regions approaching perforations in the extraction electrode are accelerated centrally to the negative target as beamlets of ions approaching this target concentrically from all directions of the inner surface of the extraction electrode. They

impact the target with velocities sufficient for fusion reactions with a DC bias potential of 120 kV between these two electrodes. Significantly, the acceleration potential is DC, so the ions are accelerated in one direction, radially inward to the target. There is no provision for reverse acceleration of particles in this apparatus.

Figure 3



See figure 3. My invention is a spherical fusion reactor with a central target electrode. A spherical, insulated envelope contains a concentrically located spherical target electrode. This envelope contains rarefied fusion reactive gas. This envelope is suspended within an insulating medium which separates it from a the peripheral, external electrical ground plane. A source of high voltage alternating potential is connected between the central target electrode and this ground plane.

A Deuterium (or Deuterium and Tritium, D-T) ion plasma is produced within this envelope by electric fields present between the target and the ground plane. This field is present when the target is at a different electric potential with reference to the ground plane. The intensity of this field is in proportion to the potential difference between the target and the ground plane. The direction of this field is determined by the relative charge polarities between the target and the ground plane. With reference to a positive ion, with a positive charge on the target and a negative charge on the ground plane, the electric field direction would be such that a positively charged particle would move radially outward from the target. With a negative charge on the target and a positive charge on the ground plane, a positively charged particle would move radially inward toward the target. The rate of acceleration of a charged particle within this field is in proportion to the intensity of this field. The intensity of this field is in proportion to the potential difference between the target and the ground plane. With an alternating potential placed between the target and the ground plane, an electric field varying in intensity and polarity is produced. The maximum intensity is proportional to the peak voltage applied. As the potential difference is rising, the electric field intensity is increasing.

Figure 3 shows the system at rest, prior to application of electrical potential. The rarified fusion reactive gas is in a neutral state. The following figures will illustrate operation of the device as alternating potential is applied. The high voltage AC power supply is represented as a unit circle with an enclosed vector. It is shown rotating counter clockwise in standard notation. At 90 degrees, this represents a maximum applied potential with a polarity such that the inner target is maximally biased negatively with respect to the ground plane. At 270 degrees, the reverse is true in that the polarity is such

that the inner target is maximally biased positively with respect to the ground plane. The power supply continuously applies this alternating potential bringing the system through the sequential steps of operation as portrayed in these figures. The electric field vector is portrayed as representing the direction in which a positively charged particle would move in response to such an electric field.

Figure 4

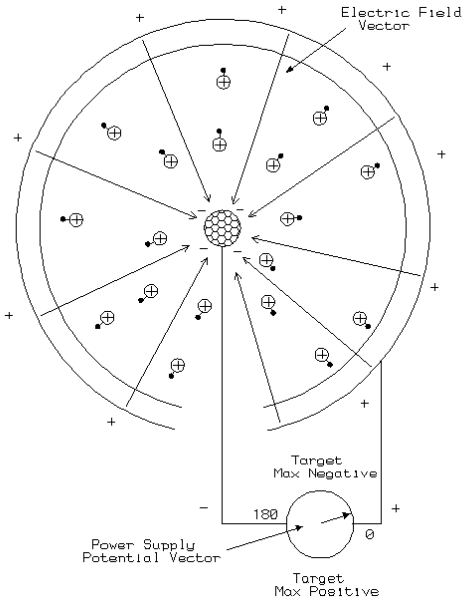


Figure 5

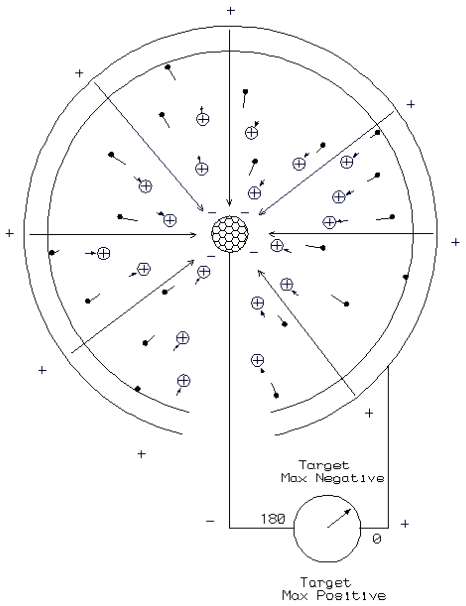


Figure 4 indicates a time in which an electric field strength sufficient for polarization has been applied. The electric field intensity becomes sufficiently intense for electric field ionization in figure 5. Once ionization occurs, the positive and negative ions are accelerated in opposite directions. The alternating potential applied is of such a magnitude that it has not reached it's peak value at the point of ionization. Observe that between the target and ground plane a current exists consisting of both moving positive and negative charge carriers.

Figure 6

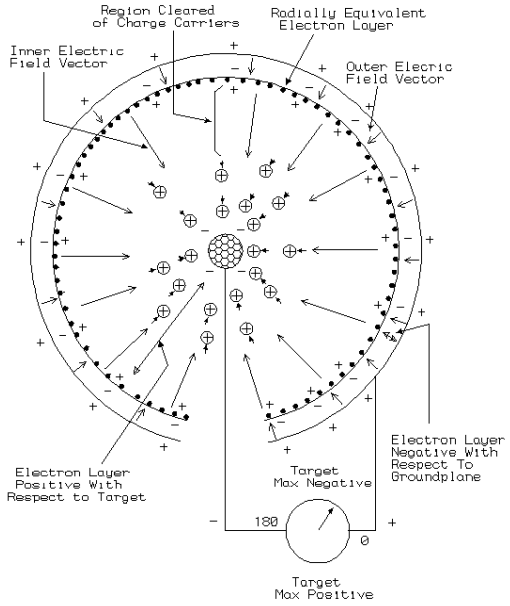
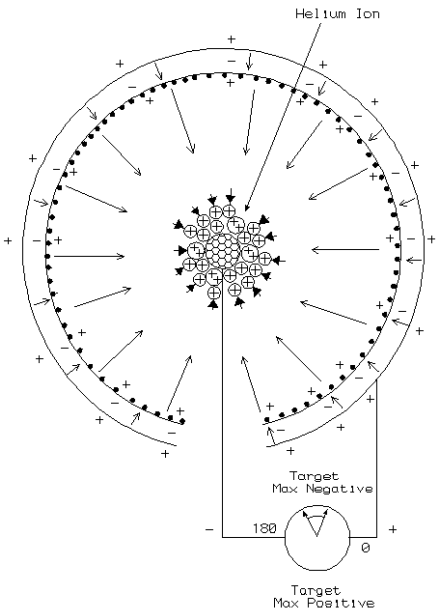


Figure 6 represents a time where in the applied potential is still increasing. Observe that the electrons have reached the inner surface of the insulated reactor envelope. Their mass is about 1/1800 th that of a proton, therefore they accelerate much faster in a given electric field. Their outward movement is stopped while the positive ions are still moving inward.

It is important to note that between the centrally collecting positive ions and the now stopped electron layer is a region cleared of charge carriers. The electrons accumulated at the inner envelope are mobile charge carriers who's motions are primarily limited to moving circumferentially about this inner surface. Their potential is defined with respect to their relative distance between the target and the ground plane. They constitute a conductive layer and form the center most two plates of a series connected capacitive voltage divider. The target and ground plane represent the respective two outer plates of this capacitive voltage divider.

The applied potential continues to increase as the AC vector approaches 90 degrees. The capacitance formed between the target and the equipotential electron layer is the inner capacitor and is of the lowest value of respective capacitance. The capacitance formed between the equipotential electron layer and the ground plane is the outer capacitor. The voltage potential in such a divider splits with inverse relationship to the relative value of the individual capacitance with respect to the total capacitance value. The greatest portion of the applied potential therefore appears across this smaller inner capacitance. It represents up to 90 % of the applied potential.

Figure 7



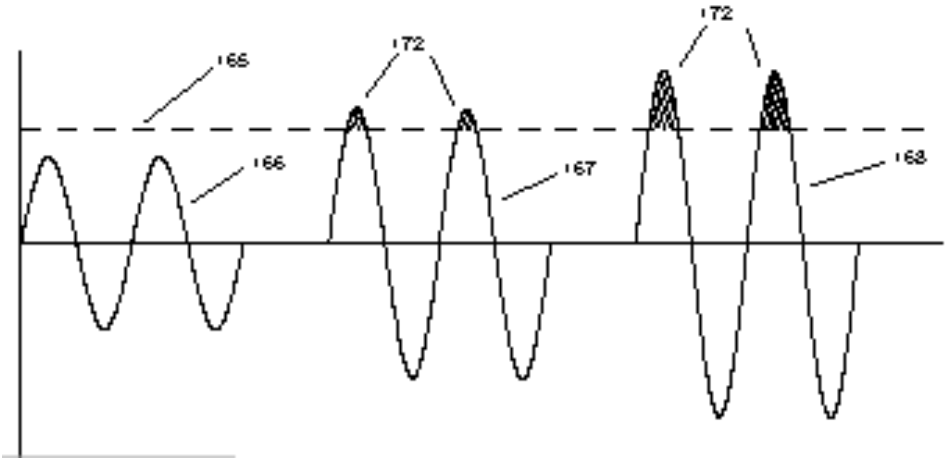
As the potential increases, the inner capacitance charges, see figure 7. Leakage current is essentially non existent, for the intervening region is depleted of charge carriers. The high potential difference between the electron layer and the target is the acceleration potential. The resultant electric field is most concentrated in this inner region.

Once the equipotential electron layer is formed, the net current through the capacitor has dropped to less than one half of it's original value. Conduction by electrons is now zero. The remaining current is solely due to the inward movement of the positive ions approximating the central target. Once all these ions impact the target, the current through the capacitor drops to zero.

As these positive ions approach the central target, the size of the intervening region depleted of charge carriers continues to increase. The charge and potential difference continues to increase resulting in increasing levels of electric field strength with a polarity to drive positive ions to the target with fusion reactive velocities.

My reactor and Livermore's paradoxically are nearly identical and at the same time radically different. During the fusion portion of my reactor's duty cycle, my reactor's operation is exactly the same as that of Lawrence Livermore's reactor: the equipotential electron layer electrically functions exactly the same as this internal ground plane within the Lawrence Livermore reactor. The Livermore device is "static" in the time domain, staying in one operational mode: accelerating ionized gases inward to the target. My reactors are "dynamic" within the time domain: cycling through an operational sequence "driven" by the cyclic nature of AC. The patent office and I debated 5 years over this one difference: DC, "static," limited time, non sustainable duration; compared with: AC, "dynamic," cyclic operation of sustainable, repetitive power impulses that can operate continuously for power production.

Figure 8



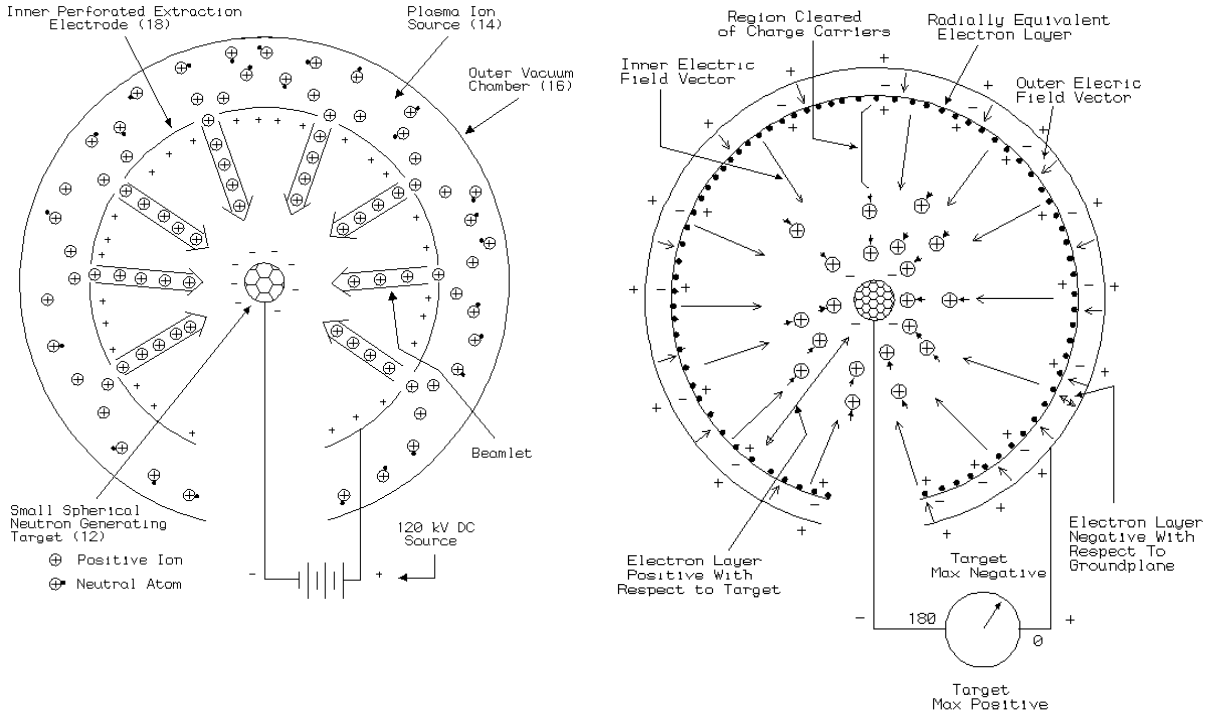


Figure 8 illustrates these facts. The top is illustrates the applied AC potential as a set of sine waves. The dotted line #166 represents the potential threshold above which fusion occurs. Fusion only occurs periodically above this potential as represented by the shaded areas #172. Fusion is shown to be a repetitive portion of the duty cycle of the applied periodic wave which continues as long as this waveform is applied. The amplitude of this waveform is a plot of the spinning vector shown representing the power supply. It's instantaneous amplitude is the sine function of that vector at a given portion of the cyclic rotation of that vector.

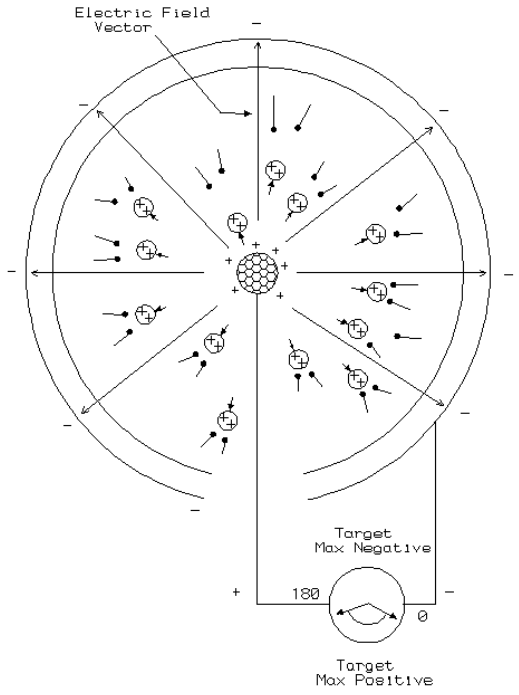
The portion of the duty cycle above the threshold represents the time period within the time domain in which fusion reactions occur. Within this given portion of the time domain, the electrical potentials within the reactor are represented by the portion of the figure at the right, a reproduction of figure 6 above. The left portion indicates the electrical potentials of the Lawrence Livermore reactor during operation, a reproduction of figure 2 above. Comparison shows that they electrically are exactly the same. The right hand figure even shows that a transitory ground plane has formed within the insulated reactor shell by the conductive layer of the electrons trapped at its inner surface. The acceleration potential is the difference in potential between this electron layer forming this "transitory inner ground plane" and the potential on the target. The acceleration potential in the Lawrence Livermore reactor is the potential applied between the permanent, physical ground plane and the target. This ground plane is a fixed portion of the Livermore reactor. The ground plane in my reactor is transitory. This key difference allows AC operation and the "dynamic" time domain cycling of my invention.

Lawrence Livermore found fusion reactive velocities with a DC bias of 120 kV between the target and an internal ground plane. With conservative estimate of the voltage splitting 50 50 between the inner and outer capacitance levels, an acceleration potential of 120 kV will exist with only 240 kV applied by the power supply. These are very conservative estimates, for the split will be much greater than 50 50 in favor of fusion.

These particles impact with the target and each other at velocities producing fusion. These fields change in polarity with the polarity potential changes of the alternating current. The ions within this enclosed space alternately accelerate inward to the target electrode, and alternately accelerate outward toward the envelope. The spherical target electrode is suspended from the envelope by an insulated stalk. When the target electrode is biased negative, with respect to earth ground, ions within this enclosed space accelerate to the target electrode producing D-D or D-T reactions. The target is loaded with D or T by the impact of the D or T ions.

The innovation of my invention is that it's internal ground plane is only a transitory phenomenon. It exists only during a short time during the inward particle acceleration phase when it's needed. At other times it is non existent or of reversed polarity. This is the difference between just one shot operation and a continuous on off operation.

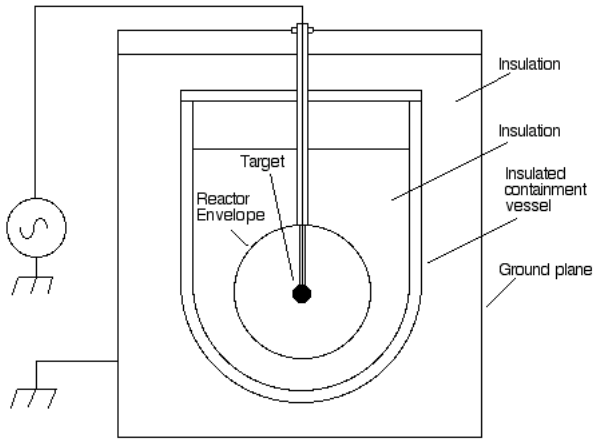
Figure 9



Another unique approach of this invention is shown in figure 9. Unlike previous attempts at fusion, the driving power supply goes into an opposite polarity time period of it's cyclic periodicity. This is represented by the power supply vector in the 180 to 360 degree portion of rotation in the unit circle. Figure 9 shows this vector pointing to an average of 270 degrees. This period is the point where the power supply applies a maximum positive potential to the target with respect to the ground plane. This is unique to fusion reactors, since particle acceleration is now in the opposite direction from that of fusion. The positive ions are moving radially outward, with electrons moving radially inward. The result is recombination back to neutral gas. This takes the process back to where it started as shown in figure 3, except that many of the ions are now the helium ion byproducts of fusion. This periodic cycle can repeat continuously as long as appropriate drive power and conditions are maintained.

Metaphorically speaking, this is analogous to an internal combustion engine as an appropriate illustration. The Livermore device is like a cylinder and piston at the beginning of the power stroke. Ignition pushes the piston down producing power. But then that's it. Its done. My device is like a cylinder, piston, connecting rod, crankshaft, and flywheel combination. Ignition pushes the piston down, power is changed into rotary motion by the connecting rod and crankshaft. Most importantly, the crankshaft and connecting rod return the piston to where it can go through the power stroke again... and again. This can be repeated continuously. Power is only produced during the power stroke. The energy absorber structure functions as a thermal flywheel smoothing these repetitive power impulses into continuous, sustained power. Extremely close as far as the power stroke is concerned. Extremely different as far as continuous, sustainable operation is concerned.

Figure 10



Envelopment of the reactor envelope within an insulating cooling medium provides for cooling of the reactor and isolates the reactor chamber from AC ground potential, figure 10. This permits a uniform equipotential surface to be developed along the inner lining of the reactor envelope. This surface is spherical and concentrically aligned with the the central target electrode. This produces a uniformly spherical electric field within the reactor envelope. This allows the electric field to focus the ions onto the target when they are accelerating inward to the target. The electric fields must be symmetrical in order to allow for fusion reactions to occur at the target. AC ground potential must be sufficiently removed from the outer surface of the reactor envelope for reliable functioning. This design provides for the removal of the AC ground potential location to be located external to the thermally insulated container holding the insulating and cooling medium. In some embodiments, this AC ground potential location may also be located externally more distant from this point. Electrical insulation of the internal and external surfaces of the reactor envelope from AC ground provides for uniformly symmetrical electric fields within the reactor chamber.

Envelopment of the reactor's insulating and cooling medium within a thermally insulated container provides for the outward transport of energy radiations with restriction of inward passage of heat energy. This reduces the thermal load of the reactor and the contained insulating and cooling medium by restriction of reabsorption of heat produced within the absorber medium.

This invention provides a highly controllable and efficient hot fusion reactor. AC drive potential provides for both ionization and target impact. The cyclic on off nature of this invention's operation allow fine power incremental control and the means of both introducing and extracting gases to and from the fusion reactions. Fine power control is obtained by the fact that the reaction is turning on and off at a high rate. Duty cycle and pulse control allow the number of reactions per given time period to be varied. In example, if the drive frequency is 50,000 Hertz, the net power output of the system can be varied in 1/50,000 per second increments by varying the number of alternations per time period in which the applied potential is of sufficient intensity to permit fusion reactions. Introduction and extraction of gases can be accomplished during and after the portion of alternation in which positive ions are accelerated outward. Control of the waveform can also let the electric field be momentarily ended in order to facilitate electron and ion recombination. Gas injection and extraction can take place during these time periods. Most significantly, the alternating polarity nature of the drive potential provides a time

means within ongoing time where the central reacting mass is disassembled. This is subsequently followed by radial acceleration of ions outward providing for a time in which gas exchange may occur. All the prior art with regards to particle acceleration and neutron tube fusion reactors does not involve reversal of particle direction as does this invention. Such devices work, but work only as one shot devices. This reactor can operate on both the D-D and the D-T reactions. The presence of a physical target limits power levels to those levels within which the target will survive.

This invention provides controllable hot hydrogen fusion efficiently. This will change the course of history. It will change all engineering priorities. It means safe and clean: energy, water, waste recycling, and propulsion of all vehicles: marine, surface, and aerospace.

References:

1. Leung, Ka-Ngo, "Spherical Neutron Generator," Issue date Nov 21, 2006, U.S. Patent US 7,139,349 B2.
2. Beuhler, R.J.; Friedlander, G.; and Friedman, L.; "Cluster-Impact Fusion," Physical Review Letters, 18 September, 1989, Volume 63, Number 12, pp 1292-1295.
3. DeLuze, James R.; "Apparatus for Hot Fusion of Fusion-Reactive Gases," Issue date Jan 3, 2012, U.S. Patent US 8,090,071 B2.