PATENT

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ENERGY GENERATION APPARATUS AND METHOD

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REFERENCED DOCUMENTS

[0001] The following documents are attached to and referred to in this application, and are incorporated by reference:

1)	D.J. Cravens and D.G. Letts, "Practical Techniques in CF Research – Triggering Methods," Tenth International Conference on Cold Fusion, 2003. Cambridge, MA: LENR-CANR.org. The paper bears the following legend: "This paper was presented at the 10th International Conference on Cold Fusion. It may be different from the version published by World Scientific, Inc (2003) in the official Proceedings of the conference." (9 pages)
2)	Russ George, "Production of ^{4}He from deuterium during contact with nano-particle palladium on carbon at 200° C and 3 atmosphere deuterium pressure," Paper presented at the American Physical Society Centennial Conference March 26th, 1999. currently available electronically at: http://www.d2fusion.com/education/catalyst_helium1.html. (6 pages)
3)	U.S. Patent No. 6,753,469 issued June 22, 2004 to Kolawa et al. for "Very high efficiency, miniaturized, long-lived alpha particle power source using diamond devices for extreme space environments."
4)	G. Baym, H. A. Bethe, C. J. Pethick, "Neutron star matter," Nucl. Phys. A 175, 225 (1971) (North-Holland Publishing Co., Amsterdam). (47 pages)
5)	The NIH Guide to Molecular Modeling: "Molecular Mechanics" currently available electronically at: http://cmm.info.nih.gov/modeling/guide_documents/molecular_mechanics_document.html#nonbond_anchor. (9 pages)
6)	"Single-Crystal YAG Reinforcement Preforms for Refractory Composites" Work done by Prashant G. Karandikar, Ronald Roy, and Uday Kashalikar of Foster-Miller, Inc. for John H. Glenn Research Center currently available electronically at: http://www.nasatech.com/Briefs/May99/LEW16665.html. (2 pages)
7)	"Microporous, Single Crystal Oxide Materials" Prashant G. Karandikar. (6 pages)

BACKGROUND OF THE INVENTION

[0002] The present invention relates generally to energy generation, and more specifically to energy generation using nuclear fusion.

[0003] While there is no shortage of people desiring to produce energy through controlled fusion, the techniques can be considered to fall into two general classes, namely hot fusion and cold fusion. Hot fusion has a sound theory, and is known to work in a fashion capable of unleashing great amounts of energy in a very short amount of time. In some instances, the energy is released in an uncontrolled manner, rendering the collection of released energy problematical and expensive, possibly prohibitively so. One set of techniques for getting the hot fusion reaction to occur at a controlled pace uses electrostatic confinement. However, extracting more energy than is used to instigate the reaction is extremely difficult, if not impossible, due to the Bremsstrahlung phenomenon. Another set of techniques uses magnetic confinement, although confinement for an extended period of time has problems

similar to those that beset electrostatic confinement. Another set of techniques explores impact fusion, but these attempts suffer from problems similar to those bedeviling the other hot fusion methods.

[0004] The history of cold fusion is, to say the least, checkered. A workable theory of cold fusion does not appear to have been articulated, and attempts to produce energy using cold fusion have generally not been reproducible and, when excess energy has been generated, have been characterized by rapid destruction of the device cores in which the reactions are occurring.

[0005] As understood, current state of the art attempts to produce "cold fusion" rely upon an effect ***best*** described as "gross loading." Gross loading is the process whereby the matrix is saturated with hydrogen nuclei to the point where a small amount of phonon energy initiates a nuclear reaction. Unfortunately, the first reaction creates additional phonons that cause a chain reaction that leads to the destruction of the lattice. This approach can create excess energy because the high loading density alone leads to a system with high Hamiltonian energy in the lattice. This higher energy state leads to phonon-moderated nuclear reactions if the loaded matrix is stimulated with additional energy inputs, including additional loading through electrolysis or other stimuli referenced in the Cravens and Letts paper.

[0006] The Cravens and Letts paper, and the associated research, demonstrate that state of the art researchers have still not recognized the connection between increased lattice energy and heat production. Russ R. George of D2Fusion, Inc. describes using ultrasonically induced multi-bubble sonoluminescence to induce fusion events, although because of the gross loading the core is quickly destroyed. In this case the sonoluminescence is both the source of hydrogen production and phonon energy. Russ R. George also claims to have a device that heats a cylinder to 400F, but no control mechanism is mentioned or described. Russ George also describes excess ^4He production from deuterium during contact with nano-particle palladium on carbon at 200° C.

SUMMARY OF THE INVENTION

[0007] Embodiments of the present invention provide a practical, controllable, source of fusion energy based on the mechanisms outlined below. This source is scalable from the Micro Electronic Mechanical System (MEMS) scale at the milliwatt / watt level to the 100-kilowatt level and possibility beyond in a single core device. In short, embodiments of the invention contemplate inducing and controlling phonon-moderated nuclear reactions.

[0008] Another aspect of the present invention provides the understanding required to design and build products based on the core technology, referred to as Quantum Fusion.

[0009] All the described implementations of this technology embodying Quantum Fusion include the following four elements.

- a reaction matrix (core);
- a mechanism for inducing phonons in the core;
- a mechanism for introducing (loading) reactants into the core; and
- a mechanism for controlling the loading of reactants and the generation of phonons so that reactants, when introduced into said core, undergo nuclear reactions to a desired degree without destroying the core.

The control system maintains the rate of phonon generation and reactant introduction at a sufficiently high level to cause a desired number of nuclear reactions to occur while ensuring that the number of nuclear reactions and their depth is limited, thereby allowing energy

released due to the nuclear reactions to dissipate in a manner that substantially avoids destruction of said core.

[0010] Associated with embodiments is a heat transfer mechanism, which may be inherent in one or more of the above elements, may be a separate element, or may have attributes of both.

[0011] In broad terms, embodiments of the invention are believed to operate as follows. Reactants (e.g., hydrogen ions from water surrounding the core) are introduced into the core (e.g., palladium), and phonons are induced in a controlled manner to provide sufficient energy to convert protons into neutrons via an electron capture mechanism. The phonon-mediated mechanism is sometimes referred to in this application as quantum compression, which is a coined term (to be discussed in detail below). The neutrons, so generated, are of sufficiently low energy to result in high cross sections for neutron-hydrogen reactions. This generates increasingly high-atomic-weight isotopes of hydrogen, resulting in ^4H, which beta decays to ^4He. The neutron absorptions and the beta decay are exothermic, and result in kinetic energy transfer to the core, which is dissipated by a suitable heat exchange mechanism (e.g., the water that supplied the reactants).

[0012] Another aspect of the present invention is that controlled loading of the core material combined with controlled stimulation of phonon production prevents excess phonon energy build up, which leads to destruction of the core material. This will allow the core to operate for extended lengths of time making it an economically viable source of energy.

[0013] Another aspect of the present invention is that the core is preferably constructed to provide a consistent phonon density at the desired reaction points in the core material. This allows precise control over energy liberated with respect to time and the ability of the core material to dissipate energy to the heat transfer medium. In specific embodiments, the phonon density is controlled so that the fusion reaction occurs primarily near the surface of the core, thus preventing the type of catastrophic damage to the core that has characterized many prior art efforts to produce repeatable, sustainable energy generation.

[0014] In some embodiments of the present invention, the reaction may be initiated using current as the phonon initiator mechanism. In other embodiments of the present invention, acoustic energy such as sonic or ultrasonic energy can be used as the phonon initiator mechanism.

[0015] In one aspect, apparatus for energy generation comprises: a body, referred to as the core, of a material capable of phonon propagation; a mechanism for introducing reactants into the core; a mechanism for inducing phonons in the core so that reactants, when introduced into the core, undergo nuclear reactions; and a control system, coupled to the mechanism for introducing reactants and to the mechanism for inducing phonons, for controlling the number of nuclear reactions and the depth of the nuclear reactions in the core so as to provide a desired level of energy generation while allowing energy released due to the nuclear reactions to dissipate in a manner that substantially avoids destruction of the core.

[0016] In another aspect, a method for energy generation comprises: providing a body, referred to as the core, of a material capable of phonon propagation; introducing reactants into the core; generating phonons in the core to provide energy for said reactants to undergo nuclear reaction; and controlling the rate of reactant introduction and the rate of phonon generation so as to control the number of nuclear reactions and the depth of the nuclear reactions in the core so as to provide a desired level of energy generation while allowing

energy released due to the nuclear reactions to dissipate in a manner that substantially avoids destruction of the core.

[0017] A further understanding of the nature and advantages of the present invention may be realized by reference to the remaining portions of the specification and the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] FIG. 1 is a high-level schematic diagram showing the elements common to the various embodiments of the invention;

[0019] FIG. 2 is a schematic diagram of a first embodiment of the invention including electrolytic loading and quantum compression via current pulses through the core material;

[0020] FIGS. 3A-3C are circuit schematic diagrams showing circuitry suitable for various implementations of the first embodiment of the invention;

[0021] FIG. 4 is a schematic diagram of a second embodiment of the invention including electrolytic loading and quantum compression via sonic / ultrasonic induction of phonons;

[0022] FIG. 5 is a schematic diagram of a third embodiment of the invention including a fluidized bed or powdered style core, direct reactant injection and quantum compression via sonic / ultrasonic induction, and will likely require the use of deuterium fuel as there is no readily available source of electrons for the creation of neutrons. When using deuterium there is no net consumption of electrons, electrons only act as a catalyst.

[0023] FIG. 6 is a schematic diagram of a fourth embodiment of the invention including an isolated reactant interacting with a fluidized bed or powdered style core utilizing direct reactant injection. This figure shows quantum compression in any one or combination of ways including; 1) sonic / ultrasonic induction, 2) quantum current, 3) thermal (if using method other than quantum current, it will normally be necessary to use a fuel resulting in no net absorption of electrons;

[0024] FIG. 7 shows an implementation where one or more surfaces of the core are in contact with the reactant source and one or more surfaces of the core are in contact with a separate heat sink; and

[0025] FIG. 8 is a representative timing diagram showing how the loading and quantum pulses can be controlled.

DESCRIPTION OF SPECIFIC EMBODIMENTS

Overview

[0026] FIG. 1 is a very high level schematic representation of a Quantum Fusion reactor 10 encompassing a number of embodiments of the present invention. At the heart of the reactor is a reaction matrix or core 15 capable of phonon propagation. The general operation is for a reactant-loading mechanism 20 to load core 15 with reactant (e.g., protons) from a reactant source 25, and generate phonons in the core material using a phonon-inducing mechanism 30. A control system 40 activates and monitors reactant-loading mechanism 20 and phonon-inducing mechanism 30.

[0027] The phonon-inducing mechanism may stimulate phonons in the core directly using one or more means such as sonic / ultrasonic waves, current, or heat. Phonon energy causes displacement of the core lattice nuclei from their neutral positions. In the case where this displacement moves lattice nuclei closer together the density increases and is further increased by the presence of hydrogen nuclei (^{1}H (protium), ^{2}H (deuterium), or ^{3}H (tritium)). As the density increases, the Fermi energy of the electrons increases, and so it becomes

energetically favorable for an electron and proton to combine to make a neutron and a neutrino. The neutrino escapes from the reactor; however the electron capture results in an overall reduction of system energy by ~782KeV. The resulting low-energy neutron has a high cross section of reaction with other H, D, or T nuclei. The formation of a deuteron from protium releases ~2.24MeV, the transition of D to T releases ~6.26Mev and the transition to ^4H with the subsequent β^- decay releases ~22.36MeV. Due to the wave nature of phonons and the associated density function driving the electron capture the overall momentum of the resulting ^4H is low enough that β- is the decay function. Associated with the reactor is a heat transfer mechanism 45, which may be inherent in one or more of the above elements, may be a separate element, or may have attributes of both.

[0028] Control system 40 is shown having bi-directional communication with reactant-loading mechanism 20 via a control channel 50 and with phonon-inducing mechanism 30 via a control channel 55, and additional communication paths are shown. While the communication between the control mechanism and the reactant-loading and phonon-inducing mechanisms will usually be associated with electrical connections, the communication paths are intended to be very general. For example, as noted above, the phonon-generation mechanism may use ultrasonic energy or heat.

[0029] Control system 40 is also shown as having bi-directional communication with core 15 and heat transfer mechanism 45 via control channels 60 and 65. These additional control channels would allow an additional ability to control the reaction, but or both may be unnecessary in some embodiments. In some embodiments, these control channels provide signals from pressure and temperature sensors.

[0030] Control system 40 is shown as an enlarged detail with specific connections. More specifically, from the point of view of control system 40, control channel 50 is shown as having control outputs 50a and 50b, and a control input 50c. Similarly, control channel 55 is shown as having control outputs 55a, 55b, and 55c, and a control input 55d; control channel 60 is shown as having a control outputs 60a and 60b, and control outputs 60c and 60d; and control channel 65 is shown as having control inputs 65a and 65b, and control outputs 65c and 65d.

[0031] The same reference numbers will be used in the different embodiments, with the understanding that what are seen as control inputs and outputs from the point of view of control system 40 will be seen as control outputs and inputs from the point of view of reactant-loading mechanism 20, phonon-inducing mechanism 30, heat transfer mechanism, and core 15. Different embodiments may have different combinations of control inputs and outputs.

[0032] Four specific embodiments of a Quantum Fusion reactor are described in detail below. A first embodiment (FIGS. 2 and FIGS. 3A-3C) uses an electrical field to control loading of the core material and current pulses as part of the phonon-generation mechanism. A second embodiment (FIG. 4) uses an electrical field to control loading of the core material and sonic or ultrasonic energy as part of the phonon-generation mechanism. A third embodiment (FIG. 5) uses a fluidized bed of core material. Reactant is pumped directly into the reaction chamber to control core loading. The fluidized bed is capable of phonon propagation. Phonon generation in the fluidized bed may be stimulated by directly imparting sonic / ultrasonic energy, current, or a combination of both. A fourth embodiment (FIG. 6) is a sealed container device in which the loading rate is controlled by the combination of reactant gas pressure and the temperature of the core material. The elements have been

numbered such that elements having equivalent or analogous function from embodiment to embodiment have the same identifying reference number.

Common Features of the Preferred Quantum Fusion Embodiments

[0033] The following table sets forth the basic elements of the embodiments, the first four of which were briefly outlined above.

15	Core 15 comprises a lattice type material (magnesium, chromium, iron, cobalt, nickel, molybdenum, palladium, silver, tungsten some ceramics, etc.) capable of propagating phonons, loading reactants, and supplying valence or conduction band electrons. FIGS. 5 and 6 show a fluidic or powder bed implementation of the core where the reactants are readily absorbed by the liquid or powder core material. FIG. 6 shows a version where the reactants and core material are isolated from the heat transfer medium.
30	Phonon-inducing mechanism 30 has as its primary function transferring energy to the core in the form of phonons. A second function, for cases where the loading is induced by means of an electric field, is allowing the entire core to be given a negative charge with respect to the anode. This provides for uniform loading of the core. In FIG. 6 the Quantum compression may be induced in three separate ways; 1) sonic / ultrasonic induction, using the impedance match and energy feed through horn, 2) Quantum current, induced using the feed-through horn as one electrode and the dashed line as the other, 3) Thermal, using the heating element connected using the dash dot lines.
25	The source of the reactant.
45	Heat transfer medium 45 will in some instances include water. In systems where hydrogen is the reactant material it is possible to use the flux of alpha particles as an electromotive force and as a medium for system heat removal. See U.S. Patent No. 6,753,469.
40	Control system 40 communicates with reactant-loading mechanism 20 via channel 50, with phonon-inducing mechanism 30 via channel 55, with sensors via channel 60, and with the core via channel 65.
70	Anode of systems using an electric field for loading of reactants in the form of positive ions. More generically a reactant feed.
75	Cathode or minus side of the loading current source or other ion delivery system. Should be coupled to the core to allow uniform loading of positive ions into the core. More generically, a reactant return.
50a	Control output 50a provides on/off control for the loading source in electrically loaded systems. In non-electrically loaded systems, this can control the flow of reactants FIG. 4 or extract reactants FIG. 5.

50b	Control output 50b is used to set the level for loading source. In electrically loaded systems, this would set the current level. In other systems, it could control circulation of reactants or speed of reactant injection.
50c	Control input 50c is used to monitor the reactant loading system. With electrically loaded systems it can provide information on the level and state of the reactant / heat transfer medium. On non-electrically loaded systems it can provide pressure, density, or other operating parameters.
20	Reactant-loading mechanism 20. In devices using electrolytic loading (FIGS. 2, 3A-3C, and 4), this is the current source for loading positive ions into the core. In FIG. 5 it is a pump and or a flow control valve. In this figure the fuel source may simply be turned off to stop the reaction. In FIG. 6 mechanism 20 is used to pressurize the reaction chamber. By loading the reactant in through the bottom inlet buried in the core material it facilitates loading of the reactants. The circulation return line may be used to evacuate the fuel from the reaction chamber for rapid shut down. The circulation return line also allows mechanism 20 to circulate the reactants through the fluidic or powdered core aiding in uniform reaction rates.
55d	Control input 55d is used for monitoring the quantum compression and is used for determination of the fusion efficiency as well as the status of the core. Depending on the core material, temperature and input energy level, the values returned through this sensor(s) will aid in determining the state of the core.
55a	Control output 55a is used as a control input to set the power level of the quantum compression delivered to the core.
55b and 55c	Control outputs 55b and 55c are only applicable to devices using quantum current as the phonon generation source, and determine the direction of the quantum current pulse. Alternating the direction of current maintains uniform loading of the core material.

[0034] FIG. 2 shows schematically an embodiment with electrolytic loading and current pulses for phonon generation. A pulsed loading current increases reactant density at the surface of the core. Short, quantum current pulses can be used to initiate phonon generation. These quantum current pulses also increase electron density at the core surface, due to and exploiting the skin effect, raising the rate of neutron generation via electron capture at the surface and preventing gross loading which leads to core destruction. In this embodiment, a suitable isolation technology is used to connect both ends of the core material to the phonon generator. The isolation of the quantum current from the loading current allows better control over reactants in the first fusing stage that creates neutrons.

[0035] Control system 40 varies and monitors the power associated with both loading current and quantum current. For any given reactor using a quantum current to activate the core, changes in the power level (voltage*current) at any given temperature / current operating point is indicative of changes of the core being monitored. The loading system power (voltage*current) for any given loading current level can also be monitored to provide information on the system status. For reliability purposes the control system designer (during initial development) and the system operator (during routine operation) should run the system to be controlled while varying one parameter at a time to characterize the system. This will build a multi-dimensional control space where different points with in the space will indicate problems such as core degradation, low water level, liquid pH problems and or scaling of the core.

[0036] Reactant-loading mechanism 20 in FIG. 2 can be a pulse transformer or other current source of sufficient compliance to create the loading current required to drive electron capture events. The loading current value is dependent on temperature, core cross-section, loading surface area, and compression current. An example of a functional reactor parameter set is quantum current pulse values of 4A for 40 ns at a 100KHz rep rate, with a loading current on the order of 100mA at a water temperature of 65C with a 0.05mm wire core with on the order of 5cm immersed in the water.

[0037] FIGS. 3A and 3B are circuit schematics showing possible implementations of reactant-loading and phonon-generation circuitry.

[0038] FIG. 3C shows a particular implementation. Core 15 is connected to a connection point J1, which connects the reactor core to the secondary of a transformer T8, which is used to isolate the core the phonon-inducing mechanism. The center tap on the secondary of transformer T8 is attached to the cathode 75 of the loading current source (F04 is the connection point of the cathode), providing uniform loading of the core material. The device can be made to work with a non-center-tapped connection but this can lead to non-uniform loading leading to uneven heating of the core which could actually be used to benefit in a high axial flow rate parallel to the core system.

[0039] Capacitor C5, SCR U5, and SCR U6 provide for symmetrical quantum current pulses in the clockwise and counterclockwise directions, which aid in uniform loading and reaction rates in the core. Outputs from half-bridge driver U4 drive the gates of the SCRs. Capacitor C2 is a high voltage, high capacitance low impedance device several orders of magnitude larger than capacitor C5. The voltage on capacitor C2 is provided on control channel 55. SCR U6 charges capacitor C5. Using a short trigger pulse prevents excessive ringing of stray inductance between transformer T8 and capacitor C5, instead storing the energy in capacitor C5. SCR U6 discharges the charge stored in capacitor C5, providing an opposite polarity quantum current pulse. The SCRs are controlled to control the direction of the quantum current pulse, shown as receiving signals over control channels 55b and 55c in FIG. 2.

[0040] This type of driving arrangement gives very fast rise time and short duration quantum current pulses, enhancing the skin effect and concentrates reactions at the surface of the core. This helps to prevent damage from deep and excessive loading of the core material. By adjusting the voltage on capacitor C2 (control channel 55a) it is possible to directly control the power of the quantum current pulses. The required current level of the quantum current pulses varies depending on the temperature, core cross-section, core surface area, loading rate, and power generation needs of the system. The power level can also be used to detect a change in status of the core, indicating core integrity issues.

[0041] A current transformer T2 used for measuring the loading current entering the core. The loading power entering the system can be calculated by multiplying the value of current measured on transformer T2 by the voltage across the loading current source. The loading current power measurement allows feedback of such system conditions as water Ph, pressure, and water level. The water can function as the heat transfer mechanism. The anode of the current loading source is preferably made of a material that will not be attacked by oxygen at the desired operating temperatures. The voltage across a resistor R2 and transformer T1 provides a measure of the quantum current while the voltage across connection points P11 and P12 provides a measure of the voltage. The product provides a measure of the power of the quantum current compression pulses.

[0042] Control of the reactant-loading and quantum compression levels can be similar, for example comprising a capacitor with an electronic switch on the primary of a transformer controlled by the on/off mechanism.

[0043] FIG. 4 is a schematic of an embodiment, phonon-inducing mechanism 30 is implemented by an ultrasonic transmitter to that the quantum compression is delivered in the form of ultrasonic energy. The core of this embodiment may have the same characteristics as the core in the embodiment shown in FIG. 2, and electrolysis is again responsible for loading. A current source is the preferred loading control method. For the reactant source, a liquid is recommended to simultaneously accomplish the heat transfer function. Core 15 is connected to the ultrasonic transmitter using an impedance match device 80 and feed-through to the inside of the reaction vessel. In analogy to the above embodiment shown in FIG. 2, control channel 55a controls the quantum compression power, which is converted to ultrasonic energy by the ultrasonic transmitter. Reactant loading is controlled along the lines of the embodiment shown in FIG. 2.

[0044] Control system 40 collects information from the loading source feedback via control channel 50c and phonon generator feedback via control channel 55d, as well as other system inputs, to determine the correct inputs to reactant-loading mechanism 20 and determine the correct quantum compression power to be supplied to phonon-inducing system 30. The former is effected via signals on control channels 50a and 50b; the latter via signals on control channel 55a. These are controlled in order to achieve the desired rate of fusion. Due to the lack of quantum current it may be necessary to at least initiate this type of device with deuterium. The advantage if using deuterium is that there is no net neutron production required.

[0045] FIG. 5 is an embodiment wherein core 15 is in the form of a fluidic bed (i.e., a bed of small particles). A possible suitable material would be palladium-plated carbon black, which is commercially available for use as a catalyst, e.g., from Sigma-Aldrich Co., 3050 Spruce Street, St. Louis, MO 63103 or Shanghai July Chemical Co., Ltd., 2999 Zhangyang Road, Pudong, Shanghai City. China 200135. Alternatively, the core could be a porous ceramic. Phonon-inducing mechanism 30 is implemented by an ultrasonic transmitter, which transmits ultrasonic energy into the reaction vessel using an impedance match device and feed-through so as to transfer the energy into the core and set up the phonons required to provide the inter atomic energy needed to achieve the electron capture phenomenon. The ultrasonic energy is controlled via control channel 55d.

[0046] The loading of reactant 25 is dependent on the phase of the reactant. If it is a high-pressure gas, reactant-loading mechanism 20 may be a simple metering device for charging the vessel, and the source of signals over control channel 50c may be a pressure gage. In the pressurized vessel embodiment, the reactant feed (70) works with reactant return line (75) to

circulate the reactant through the core to stir the helium out of the core and keep fresh reactant in contact with the core material.

[0047] As in the embodiments shown in FIGS. 2 and 4, control system 40 collects information from the loading source feedback via control channel 50c and phonon generator feedback via control channel 55d, as well as other system inputs, to determine the correct inputs to reactant-loading mechanism 20 and determine the correct quantum compression power to be supplied to phonon-inducing system 30.

[0048] FIG. 6 shows an embodiment similar to that shown in FIG. 5, except that the phonon production can be delivered in the form of ultrasonic energy, quantum current, or sufficient thermal energy, shown as an electric heater 85. Ultrasonic and quantum current have the advantage of faster response time and better phonon distribution. As in the embodiment of FIG. 5, the reactant is directly injected into the core material, which may be in the form of a fluidic bed. If no quantum current is provided it may be necessary to fuel this type of device with deuterium.

Theory of Operation

The Source of the Observed Energy in so called "Cold Fusion"

[0049] Unlike the common assumptions involved in "Cold Fusion," it is believed that the energy released in these reactions is the result of neutron capture by hydrogen isotopes and the beta decay of ^4H to ^4He. The energy released by neutron capture and beta decay is given by the following equations relating the masses of reacting components to products:

(neutron + $^1H - ^2H$) x c^2	=	02.237 MeV	=	0.358 pico-joule
(neutron + $^2H - ^3H$) x c^2	=	06.259 MeV	=	1.003 pico-joule
(neutron + $^3H - (\beta^- + ^4He)$) x c^2	=	19.577 MeV	=	3.137 pico-joule

The Source of the Free Neutrons

[0050] The neutrons participating in these reactions are the product of flavor change of protons that have been loaded into the core crystal lattice. The flavor change represents the transmutation of the proton into a neutron by a process similar to electron capture. Neutron generation requires a crystal lattice capable of generating phonons, capable of loading hydrogen ions, and which can supply valence or conduction band electrons, providing the ~511KeV electron mass. The required system is one that can achieve a total Hamiltonian energy of ~782KeV. This value represents the difference in mass between the proton-electron combination and the mass of the neutron. This combination leads to the transformation of a proton and electron into a neutron. This is an endothermic reaction that leads to an overall lower system energy level. The system is converting only enough energy (mass) to affect an electron capture, leaving the resulting neutron at an extremely low energy level. The resulting low energy neutron has a high cross section of reaction with respect to $^{(1-3)}H$ nuclei in the lattice. This neutron capture is similar to the process leading to a neutron star as discussed in the Baym, Bethe, and Pethick article, and applies to the H, D and T caught in the lattice and further enhanced by the quantum currents which allows the lower loading in this system.

[0051] It is believed that that energy is transferred to the protons through superposition of multiple phonon wave functions within the lattice of the core. This energy grows very rapidly as the non-bonded energy is extremely asymmetric. As mentioned in the NIH Molecular Modeling document, "Repulsion is modeled by an equation that is designed to

rapidly blow up at close distances ($1/r^{12}$ dependency)." Additional energy beyond the phonon energy is realized from atomic band state confinement of ions. When local loading of the lattice is high, hydrogen ions take up positions at the octahedral points of vacant $S_{(n+1)}$ electron orbitals between the $PnS_{(n+1)}$ orbital wave function energy levels in transition metals. This wave function energy level occupation provides confinement necessary for what is referred to as Quantum Compression, a property arising out of the Heisenberg Uncertainty Principle. Because both the electron and proton are fermions, the ions so trapped experience confinement effects. This confinement energy effect is a function of the Heisenberg Uncertainty Principle as stated in the form $\Delta\rho \geq(h/2\pi)/\Delta x$ and can be enhanced through increased electron density causing occupation of adjacent bands. The conversion of a proton to a neutron is a natural energy reduction mechanism (it requires the addition of $\sim 1.253 \times 10^{-13}$ J), converting energy to the mass difference between the proton-electron combination and the mass of a neutron. Because the transmutation is endothermic in nature, the system achieves higher entropy through the transmutation. The transmutation results in low-energy neutrons that have a high cross-section with respect to other hydrogen nuclei, giving an elevated reaction probability.

[0052] Energy released in the neutron absorptions interacts with lattice phonons in such a way that it is translated into kinetic energy in the lattice where it is dissipated into the surrounding environment (heat exchange mechanism).

[0053] It is the understanding of the reaction at the quantum level that reveals how to obtain the control and reliability required for commercial applications. Below is an outline of the steps involved in the reaction. By understanding the underlying mechanism that initiates a Quantum Fusion reaction it will be possible to use the knowledge contained in this patent to meet most of the world's energy needs today and for the foreseeable future. Phonon-Moderated Nuclear Reactions proceed most efficiently in the following way:

1. A loading pulse causes dissociation of reactant into ions by electrolysis.
2. Electrolysis drives free reactants into the core substance. The loading pulse also increases the ion density at the surface of the core. From U.S. Patent No. 6,248,221 "An investigation of catalytic dissociation of gas molecules has found that dissociation can follow several paths, e.g., direct reactions and the formation of transient states, as discussed in the article by J. Jellinek entitled "Theoretical Dynamical Studies of Metal Clusters and Cluster-Ligand Systems," (Metal-Ligand Interactions: Structure and Reactivity, N. Russo (ed.), Kluwer Dordrecht, 1995.). Electric fields, which are extremely strong at the surface of the reaction material, serve to attract these dissociated molecules to the material's surface. Advantageously, some of the hydrogen piles up at the material's surface, and then enters the material due to kinetic energy directed along electric field lines."
3. The core is a material, (magnesium, chromium, iron, cobalt, nickel, molybdenum, palladium, silver, tungsten some ceramics, etc.) capable of propagating phonons, loading reactants, and supplying valence or conduction band electrons. The following are descriptions of possible methods for achieving quantum compression. The quantum compression method allows the Quantum Fusion reaction to be initiated near the surface of the core, avoiding the core destruction inherent with deep loading.
4. The electrons provide ~511KeV of mass. The required core system is able to achieve a total Hamiltonian energy of ~782KeV at reactant trapping points. This phonon

energy, in combination with the electron and its associated momentum, supply the total mass required to convert a proton to a neutron, allowing nuclei to fuse.

5. The present invention can provide the additional energy required for the transmutation in one of two ways. The first way is by synchronizing an electrical current through the cathode (quantum current) with the electrolysis (loading) pulse. The high current, high frequency-content pulse through the matrix induces the creation of required phonon energy. Second, this energy may also be supplied by inducing phonons using a sonic or ultrasonic transmitter suitably coupled to the core material.

6. Protons loaded into the crystal lattice occupy positions in the conduction band of lattice atoms and obey Bloch's Theorem. A Bloch wave or Bloch state is the wave function of a particle placed in a periodic potential (a lattice). It consists of the product of a plane wave and a periodic function $u_{n\mathbf{k}}(\mathbf{r})$ which has the same periodicity as the potential:

$$\psi_{n\mathbf{k}}(\mathbf{r}) = e^{i\mathbf{k}.\mathbf{r}}\, u_{n\mathbf{k}}\,(\mathbf{r})$$

The plane wave vector **k** multiplied by Planck's constant is the particle's *crystal momentum*. It can be shown that the wave function of a particle in a periodic potential must have this form by proving that translation operators (by lattice vectors) commute with the Hamiltonian. This result is called Bloch's Theorem. The H nuclei in these locations come under extremely high field pressure from the surrounding lattice nuclei. When phonon energy reaches a magnitude of ≈782KeV in the vicinity of an H nucleus it becomes energetically favorable for an electron capture event. The resulting neutron is in a very low energy state with a correspondingly high cross section of interaction with existing H nuclei.

7. According to quantum field theory, the potential energy of the Hamiltonian can be expressed in terms of fermion and boson creation and annihilation operators such that a set of processes is defined in which a fermion in a given eigenstate either absorbs or emits a boson (phonon), thereby being pushed into a different eigenstate. The change in eigenstate is the change of an Up quark to a down quark, which changes a proton to a neutron.

8. (For the engineers actually designing and building Quantum Fusion reactors) The hypothesis of the core operation asserts that it is through the creation and absorption of phonons (bosons) that the energy induced as vibrations in the atomic lattice is translated to the nuclear scale, and by which the nuclear energy released by neutron absorption and transmutation is being dispersed as kinetic energy in the lattice. The phonons provide the scale coupling between electromagnetic force-level stimuli in the atomic lattice and the subatomic level increases in momentum.

9. In systems using hydrogen as the reactant, proton occupation of limited positions within the lattice and augmented by octahedral points between the $P_nS_{(n+1)}D_n$ orbital wave function energy levels in the core transition metal provides additional confinement points. There has been a fair amount of discussion within the cold fusion community of the octahedral points within the lattice being pinning points for the hydrogen ions. One of the key points missing in these discussions is a consideration of the octahedral points between the $P_nS_{(n+1)}D_n$ orbital structures in the transition metals that seem to work. It is in these available orbital wave function energy levels

that the hydrogen ion wave functions may be sufficiently confined to undergo the transmutation.

10. The quantum current pulse initiates the phonons that lead to neutron production before excessive absorbed hydrogen has had the opportunity to migrate very deeply into the lattice. Deep loading to a high density can lead to the gross loading condition of current cold fusion technology. In this condition the first reaction initiates a chain reaction of all nearby trapped H nuclei. Such a chain reaction liberates so much energy that lattice bonds break, causing disintegration of the core.

11. The proton drift current induced by the quantum current exerts a motivational force on the reactants within the lattice increasing the potential of nuclear interaction with the newly created low-energy neutrons or neutron rich material.

12. In systems using hydrogen as the reactant, the binding energy released in the creation of a ^{2}H nucleus (deuteron) is ~2.229MeV. Deuterons are neutralized in the same process as single protons and the resulting ^{2}N mass interacts with a ^{2}H. The transition from ^{2}H to ^{4}H releases ~3.386MeV. The largest yield of energy comes from the transition of ^{4}H via beta decay to ^{4}He yielding a total of ~22.965MeV in the form of phonon creation and alpha particle radiation.

Heat Transfer Mechanisms

[0054] As shown schematically in FIG. 1, embodiments of the present invention contemplate a heat transfer mechanism (denoted with reference number 45). In some embodiments, where the core is submersed or otherwise in contact with a fluid, which functions as a reactant source, the same fluid can also function as the heat transfer mechanism. In cases where the reactant is H (protium) and the core is from the transition metal group, it is possible to use water with similar treatment as would be applied in traditional boilers. Other cores and reactants will likely work by applying the quantum current / quantum compression technique.

[0055] Additional embodiments of useful reactors could include using a thermally but not electrically conductive support with a conductive core. By placing a gas source of reactant on the exposed side of the core and using electrolytic loading, the reaction could be initiated with resistive current heating of the core, with quantum currents, or a combination there of. A significant benefit of having a current flow in the core is the ability to use protium as the primary reactant. The core support would act as the heat sink and transfer the energy to what ever is desired, e.g., direct thermal conversion or a working fluid. The working fluid could be any gas or liquid down to and including the sea of electrons as discussed in U.S. Patent No. 6,753,469 referenced above.

[0056] FIG. 7 shows an implementation where one or more surfaces of the core are in contact with the reactant source and one or more surfaces of the core are in contact with a separate heat sink. The heat sink can then transfer heat to a working fluid from which heat could be extracted, either as an end in and of itself, or to run a turbine. The geometry is shown schematically. For example, the core could be a layer of material on the inner surface of a thermally conductive but electrically insulating pipe, with the reactant introduced through the interior of the pipe and the heat withdrawn from the outside surface of the pipe.

Quantum Fusion Reactor Operation and Control

[0057] The Quantum Fusion reactor implemented by electrolysis and quantum current control is driven by the stimulation of phonons in a crystal lattice. Phonon stimulation is

accomplished by stimulation event cycles consisting of a loading pulse and zero or more quantum current stimulation pulses.

[0058] FIG. 8 is a representative timing diagram showing how the loading pulses and quantum current pulses can be controlled. The timing is characterized by a series of event cycles, one of which is shown in the figure.

Event Cycles

[0059] An event cycle consists of a loading pulse and zero or more quantum current stimulation pulses. Loading pulses cause dissociation of the water into hydrogen and oxygen and promote the migration of hydrogen nuclei into the reaction matrix. Quantum current pulses stimulate phonons in the reaction matrix and ensure presence of electrons for electron capture.

Number of events — 0 – 250 (or free-run)

[0060] In the initial reactor prototype the number of events is determinable by user configuration to allow optimization of the reaction characteristics and core start-up. Free run allows the reactor to proceed according to currently configured parameters (pursuant to the implementation of a feedback system).

Event period — 10 μs – 10,000,000 μs (10μs resolution)

[0061] This parameter allows the length of time between event cycles to be controlled. This time period allows for the dissipation of fusion-induced phonon energy. Longer event periods will allow more time between loading pulses and subsequent Quantum Fusion events.

Number of quantum pulses per event – 0 – 250

[0062] This parameter allows optimization of energy production for various loading pulse amplitudes and durations, and temperature profiles. Varying the number of quantum pulses per event, allows the ratio of Quantum Fusion reaction rate and loading rate to be adjusted relative to one another. An analogy would be with multiple injection events per combustion cycle in an internal combustion direct injection engine.

The Loading Pulse

[0063] The loading pulse causes dissociation of water into hydrogen and oxygen and promotes the migration of hydrogen nuclei into the reaction crystal matrix. Varying the pulse width relative to the amplitude allows the rate of dissociation to be controlled independent of the rate of loading.

Loading Pulse Width – 50 ns – 250,000 ns (25ns resolution)

[0064] The pulse width determines the length of time loading occurs. This is an indirect control on the density and depth of loading in the reaction matrix. This is roughly analogous to a choke or mixture setting on a carbureted engine.

Loading Pulse Amplitude — 0 – 800 V (0.2V resolution)

[0065] The pulse amplitude determines the rate of dissociation, and thus, the rate of fuel availability.

Loading Pulse Offset — 0 – 250,000 ns (25ns resolution)

[0066] This offset allows the start of the loading pulse to be varied relative to the start of the quantum pulse(s). This is roughly analogous to the spark timing in an internal combustion engine.

The Quantum Pulses

[0067] The ultimate purpose of the quantum current is the creation of free, low-energy, high-cross-section neutrons. The quantum pulses are responsible for initiating phonons in the reaction matrix, imparting additional energy to the system and increasing the density of electrons available for electron capture, and consequent low-energy, high-cross-section neutrons.

[0068] According to quantum field theory, the potential energy of the Hamiltonian can be expressed in terms of fermion and boson creation and annihilation operators such that a set of processes is defined in which a fermion in a given eigenstate either absorbs or emits a boson (phonon), thereby being pushed into a different eigenstate. The change in eigenstate is the change of an Up quark to a Down quark, which changes a proton to a neutron.

[0069] It is believed that it is through the creation and absorption of phonons (bosons) that the energy induced as vibrations in the atomic lattice is translated to the nuclear scale, and by which the nuclear energy released by neutron absorption and transmutation is being dispersed as kinetic energy in the lattice. The phonons provide the scale coupling between electromagnetic force-level stimuli in the atomic lattice and the subatomic level increases in momentum.

[0070] Quantum current supplies valence or conduction band electrons, providing the ~511KeV electron mass. The quantum current is also responsible for raising the Hamiltonian energy of the reaction sites to the required ~782KeV necessary for electron capture. This value represents the difference in mass between the proton-electron combination and the mass of the neutron.

[0071] It is the intersection of these free neutrons with available hydrogen nuclei that comprises the fusion reaction path. The closest academically understood reaction paths are the R-process and S-process, which occur in stars.

[0072] A relatively low duty cycle of the quantum current pulses is typically required because effective quantum current pulse amplitude for a longer time would typically vaporize the core. There may be exceptions.

Quantum Pulse Width — 50 ns – 250,000 ns (25ns resolution) and
Quantum Pulse Amplitude — 0 – 400 V (0.2V resolution)

[0073] The individual quantum pulses can be adjusted to tune the phonon creation and energy level. Phonons will also be generated as a product of Quantum Fusion events, leading to a lower phonon stimulation energy input requirement. The energy level requirement is a function of the macro temperature of the core as a whole, the loading rate, the geometry of the core, and the duration of the loading pulse, which partially determines loading depth.

Quantum Pulse Dead Time — 50 ns – 25,000 ns (25ns resolution)

[0074] This parameter is a function of the circuit used to implement the quantum pulses and the loading rate. The pulse dead time also represents a division between quantum pulses whose direction through the core are alternated. This quantum pulse direction alternation provides for uniform loading of the core. Unidirectional quantum pulsing results in proton migration in the core leading to a potential gradient in the core and non-uniform heating.

Quantum Pulse Offset — 0 – 250,000 ns (25ns resolution)

[0075] This offset allows the start of the loading pulse to be varied relative to the start of the quantum pulse(s). This is roughly analogous to the spark timing in an internal combustion engine.

Reactor Feedback

[0076] Feedback parameters allow a commercially useful application of the reactor to be constructed with reaction parameters being adjusted in real time according to the dictates of energy demand on the system, changing pressure and temperature inside the reactor vessel.

Temperature and Pressure

[0077] This is standard boiler feedback and is used solely for process control.

Loading Pulse Power

[0078] Loading pulse power feedback provides information on the water and inter-electrode environment. A large increase in loading pulse power can be indicative of excess phonon generation leading to a vapor envelope around the core impacting heat transfer away from the core.

Quantum Pulse Power

[0079] The quantum pulse power feedback provides information on the state of core loading and possible core damage. The impedance of the core will change dependent upon the percentage of saturation of reactant in the core. Possible core damage will also lead to a persistent increase in quantum current energy due to increased resistance of the core. Impedance rise due to excessive loading density may necessitate a greater number of quantum pulses relative to loading pulses to alleviate the excessive loading condition. Sustained excess loading could lead to core degradation and/or destruction, through chained reactions leading to excess buildup of phonon energy.

Other Reactor Characteristics

Power Supply Voltage (Loading Pulse)

[0080] This sets the loading current magnitude by adjusting the voltage on the primary of the pulse transformer used for loading. Pulse amplitude determines the rate of dissociation, and thus, the rate of fuel availability.

Quantum Pulse Transformer Primary Voltage

[0081] This voltage allows the quantum current magnitude to be set from the primary side. The primary side is used to maintain isolation between the quantum current and the loading current. Using a center tapped magnetic device to couple the Quantum current energy to the core allows the core to be uniformly loaded.

Additional Implementations

[0082] Another method of using the reaction could include using a porous ceramic structure such as those offered by Foster Miller (see the Single-Crystal YAG document referenced above (NASA Tech Briefs May 1999)). The shape of the porosity as well as the net shape can be specified. This material could be plated with the desired core material. It is believed that the best results using this type material would be achieved with a porosity designed to provide a uniform cross section for a quantum current activation. With this type of core the Quantum Fusion reaction will likely initiate at the points of maximum current density but spread as the temperature rises to the level necessary to supply the remaining phonons required for proton to neutron conversion in the rest of the core. This type of core material could be installed in a sealed container along the lines of those found in radioisotope thermoelectric generator (RTG), but without the dangerously radioactive core.

[0083] One aspect of the present invention, alluded to in the preceding paragraph, is that a significant portion of the mechanical and thermodynamic infrastructure can be based on existing, commercially available technology. For example, a conventional 3-phase-electrode steam boiler, such as those available from Gaumer Company, Inc., 13616 Hempstead Road,

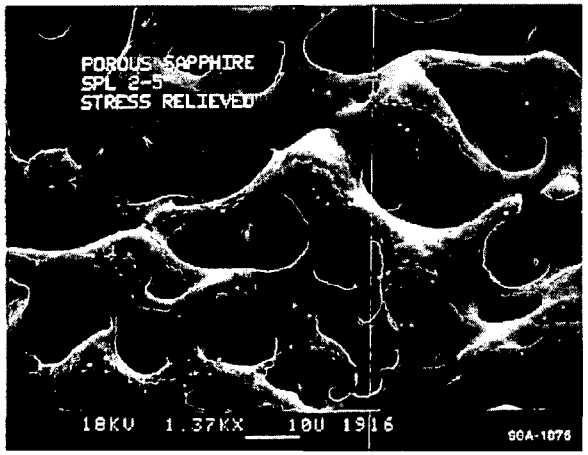
Houston, Texas 77040, can be retrofitted with a Quantum Fusion core in the following manner: using a 3 phase electrode boiler, use 2 of the three phase electrodes for cathode connection, mounting a Quantum Fusion reactor core between them, allowing quantum current stimulation, and use the third electrode as the anode. Surprisingly, this is the only mechanical modification to the device necessary.

Conclusion

[0084] While the above is a complete description of specific embodiments of the invention, the above description should not be taken as limiting the scope of the invention as defined by the claims.

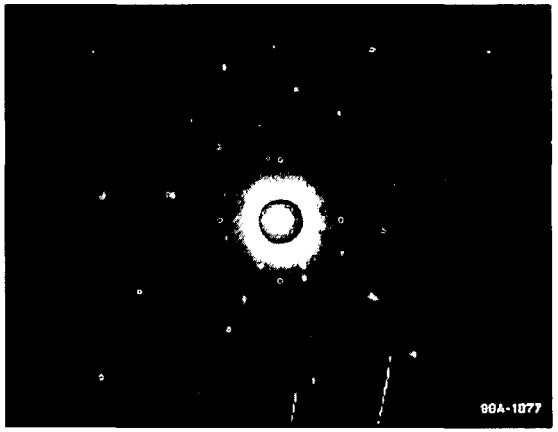
Microporous, Single Crystal Oxide Materials

For more information, contact Uday Kashalikar at (781) 684-4125 or Ron Roy at (781) 684-4183



Achievements

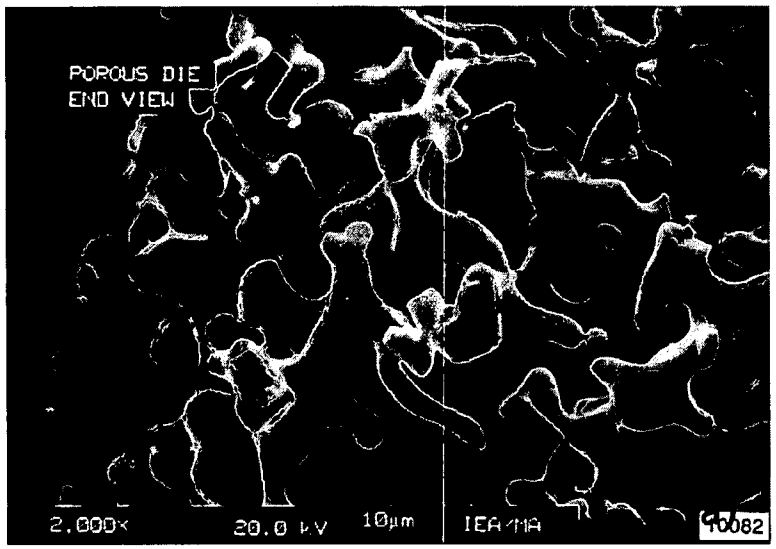
- **Random architecture capabilities**
  - **Tailorable pore size - 5 to 50μ**
  - **Tailorable sapphire strut size - 10 to 25μ**
  - **Tailorable porosity - 30 to 85 percent**
- **Directional architecture achievable**
- **Porous oxide materials grown - sapphire, YAG, eutectic YAG, magnesia alumina spinel and rare earth oxides**



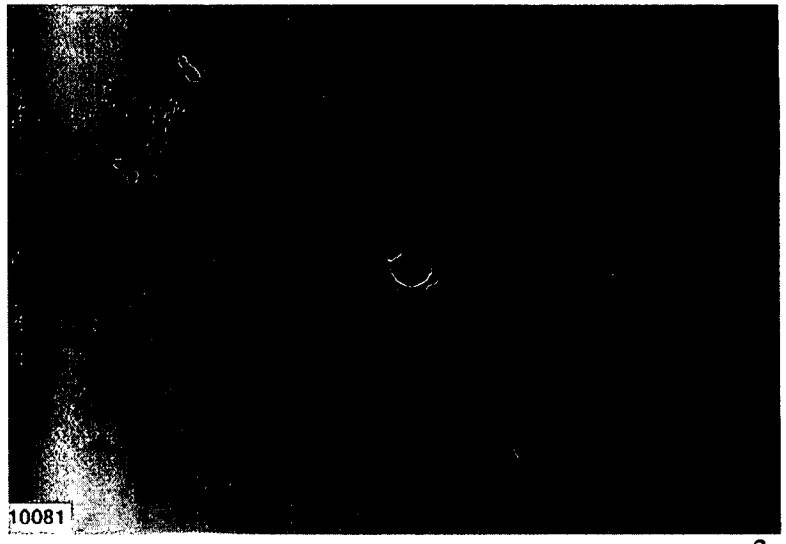
X-ray Laue back reflection diffraction pattern, spot size 1.5 mm, of random porous sapphire showing C-axis growth direction

Can process incongruent melting mixed oxides

Porous Sapphire Microstructure and X-Ray Laue Pattern

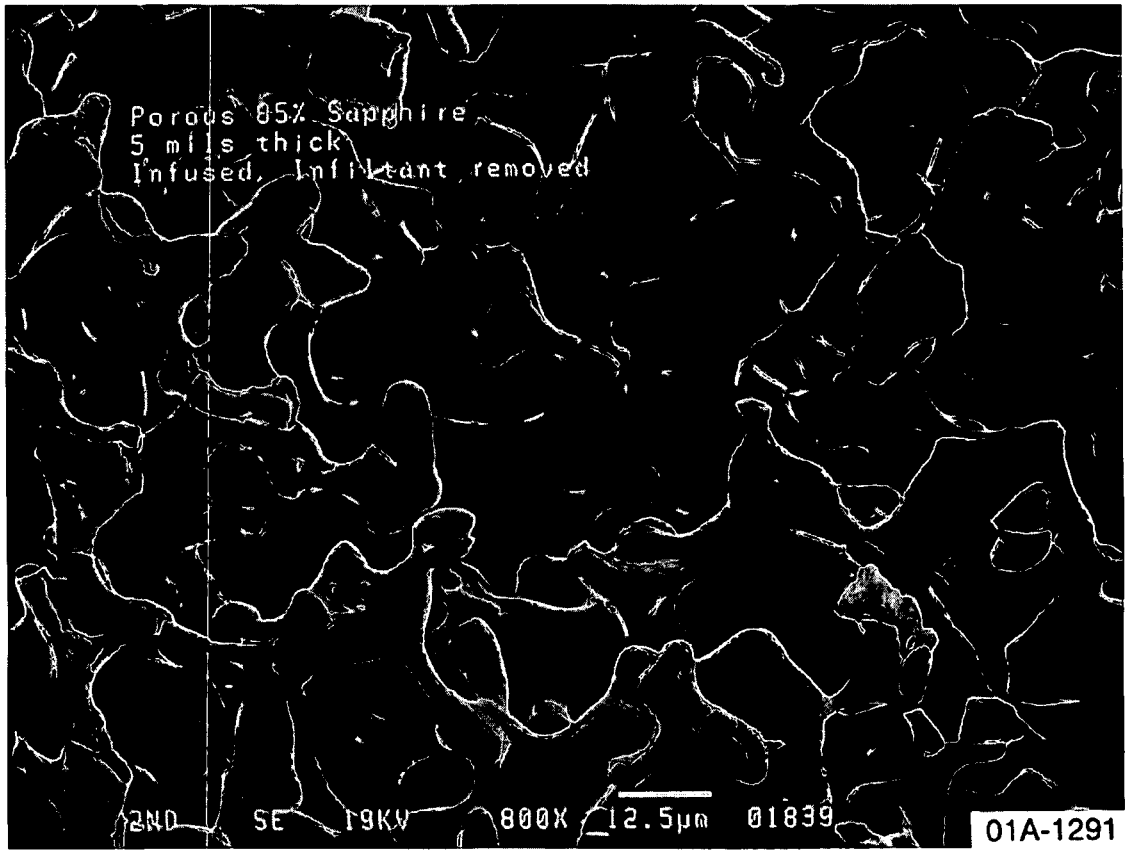


(a) Scanning electron micrograph showing the microstructure of single crystal alumina preform fabricated by the patented net-shape preform growth technology (reinforcement diameter ~10 µm)



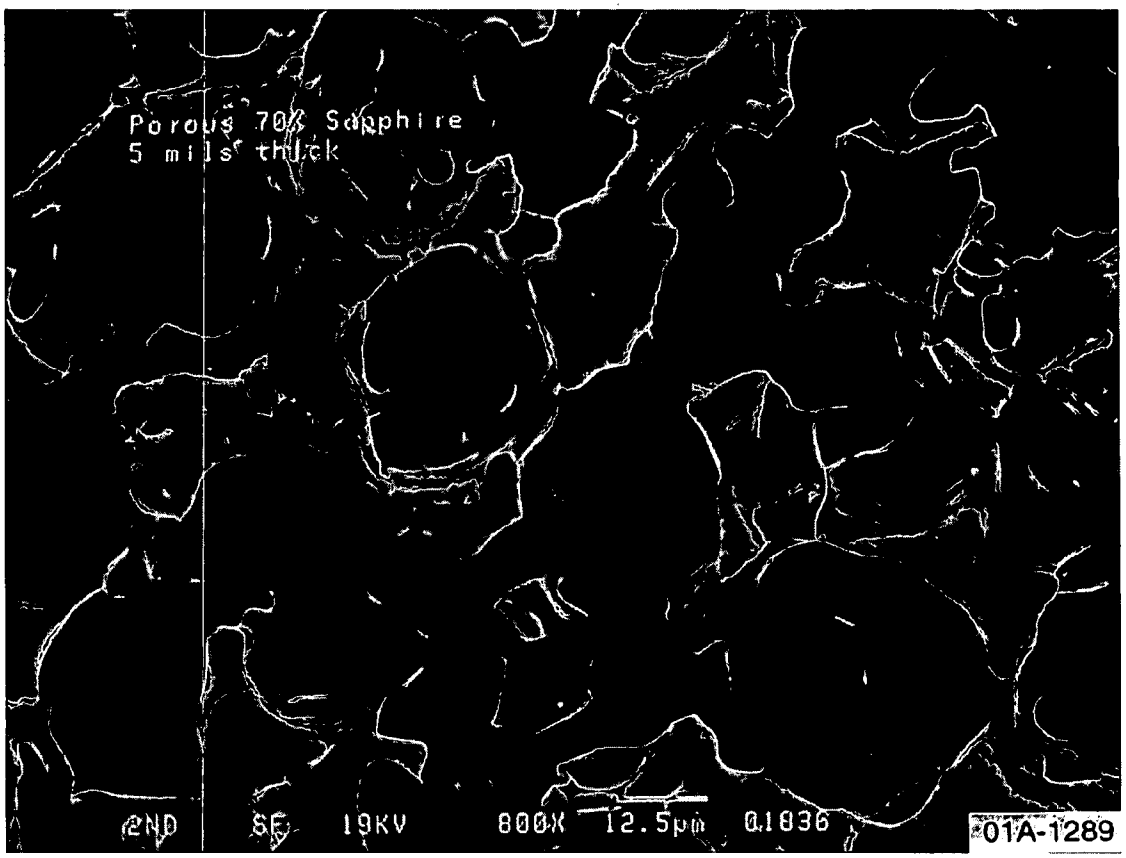
(b) X-ray Laue diffraction pattern perpendicular to the C-axis growth direction of the region in (a) showing the single crystal nature

85 Percent Porous Sapphire

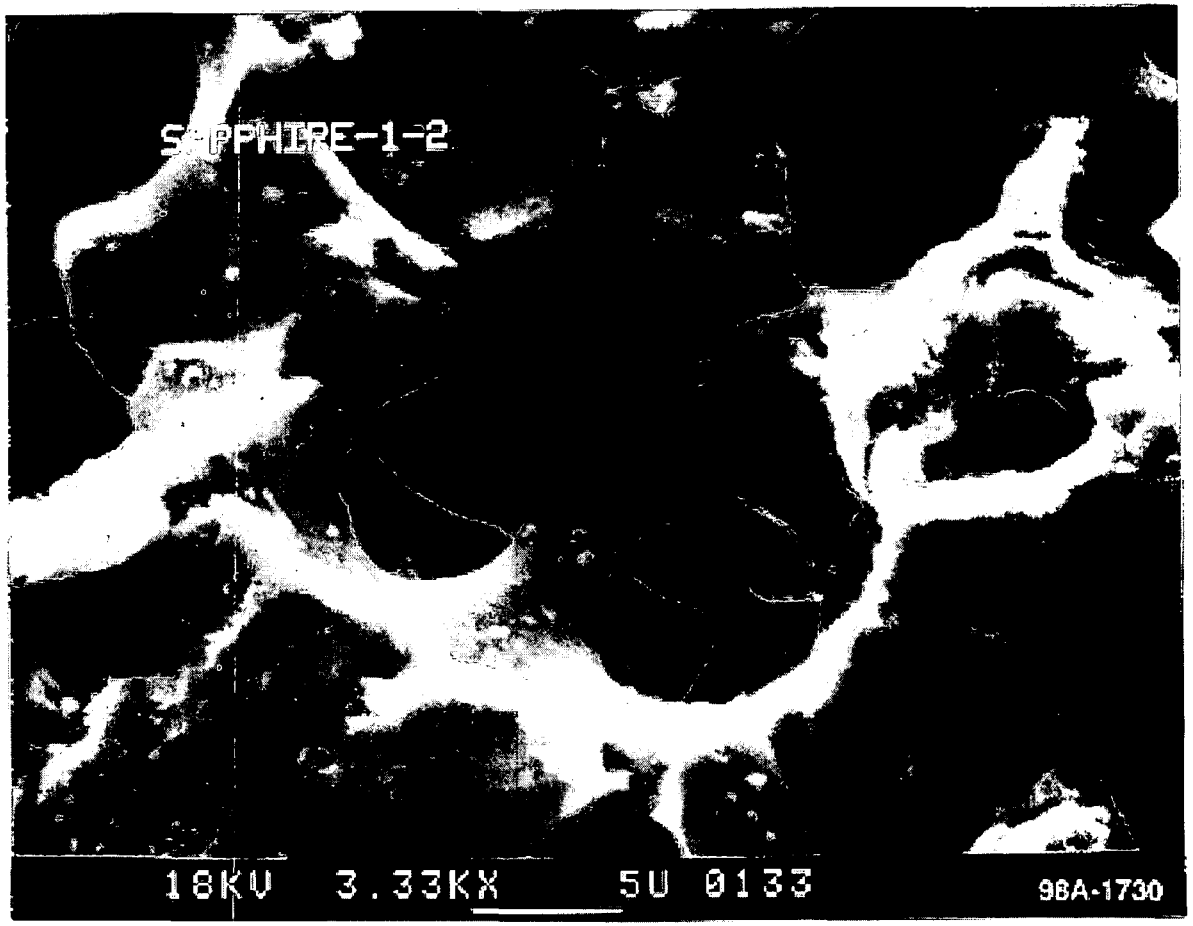


Foster-Miller, Inc.

70 Percent Porous Sapphire



45 Percent Porous Sapphire



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COTS... from the company that invented it. www.rugged.com A-tech
NuSil SILICONE

Single-Crystal YAG Reinforcement Preforms for Refractory Composites

Preforms can be made in net size and shape, with tailored orientation of fibers.

John H. Glenn Research Center, Cleveland, Ohio

Preforms (essentially, shaped mats) of single-crystal yttrium aluminum garnet (YAG) fibers can now be readily fabricated in net size and shape, with tailored orientation of the fibers. These preforms can be used as fiber reinforcements in ceramic- and metal-matrix composite materials that withstand temperatures as high as 1,700 °C. The development of these preforms and composites is a continuing effort in conjunction with other efforts to develop lightweight components for aircraft turbine engines.

The single-crystal form of YAG is needed for creep resistance; the polycrystalline forms of YAG and other oxide fiber materials do not resist creep adequately at the contemplated high operating temperatures. It would be expensive and impractical to construct preforms by weaving, braiding, or laminating premanufactured single-crystal fibers, and handling of the fibers during such construction would weaken them.

A proprietary process is being developed to overcome the above-mentioned limitations. In this process, reinforcement preforms are formed to net-shape, eliminating the need for operations such as weaving and braiding of single filaments. The net-shape preforms can have random, oriented, or mixed reinforcement in selective areas. Reinforcement volume-fraction shape and orientation can be controlled. Thin complex parts such as airfoils can be fabricated. Single-crystal porous preforms with volume percent in the range of 30 to 54 percent and strut dimensions in the range of 10 to 125 micrometers have been produced.

Figure 1 shows a scanning electron micrograph of porous single-crystal YAG reinforcement. Figure 2 shows a Laue x-ray diffraction pattern from this porous YAG preform. The Laue x-ray pattern is characteristic of single-crystal YAG, thus proving its single-crystal nature. High magnification microscopy indicated the absence of grain boundaries and confirmed the single-crystal nature. Reinforcement preforms with random, unidirectional and [0/90] reinforcement have been fabricated so far. Sufficient permeability of the preforms was demonstrated by conducting infiltration of the preform by polymer and metal matrices by pressure infiltration. Work is underway to optimize the preform rein forcing efficiency and infiltration with ceramic and intermetallic matrices.

Porous single crystals made by this proprietary approach also have applications such as selective emitters, filters, and photonic band-gap materials due to their unique physical properties. Porous single crystals of sapphire, YAG, eutectic YAG, doped sapphire, and ytterbia have been fabricated by this process and potential exists for fabricating porous single crystals of many other materials.

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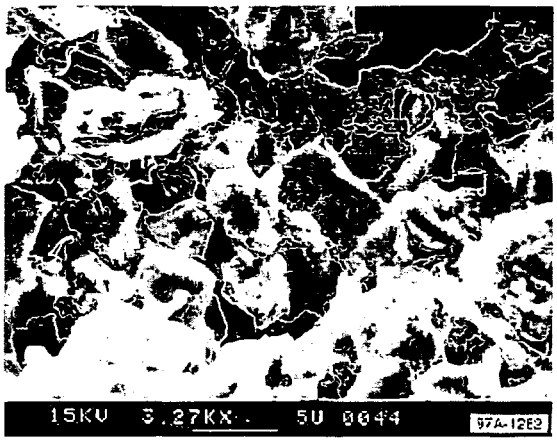

Figure 1. A **Scanning Electron Micrograph** shows a random porous single-crystal YAG.

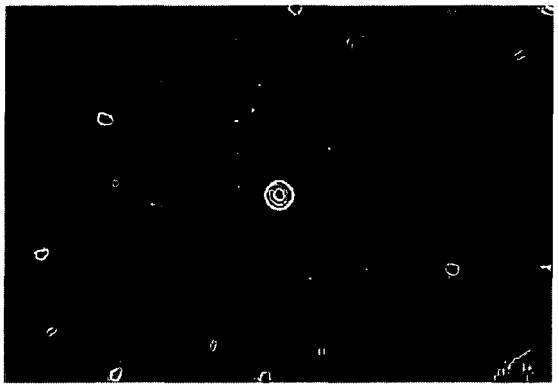

Figure 2. A **Back-Reflection Laue X-Ray Diffraction Pattern** from the preform in Figure 1 confirms its single-crystal nature.

This work was done by Prashant G. Karandikar, Ronald Roy, and Uday Kashalikar of Foster-Miller, Inc., for **John H. Glenn Research Center.**

Inquiries concerning rights for the commercial use of this invention should be addressed to John H. Glenn Research Center, Commercial Technology Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-16665.

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WHAT IS CLAIMED IS:

1. An apparatus for energy generation comprising:
a body, referred to as the core, of a material capable of phonon propagation;
a mechanism for introducing reactants into said core;
a mechanism for inducing phonons in said core so that reactants, when introduced into said core, undergo nuclear reactions; and
a control system, coupled to said mechanism for introducing reactants and to said mechanism for inducing phonons, for controlling the number of nuclear reactions and the depth of the nuclear reactions in said core so as to provide a desired level of energy generation while allowing energy released due to the nuclear reactions to dissipate in a manner that substantially avoids destruction of said core.

2. The apparatus of claim 1 wherein said mechanism for introducing reactants into said core comprises a controlled electrolysis source, electrically coupled to said core.

3. The apparatus of claim 1 or 2 wherein reactants are provided from a liquid medium, which liquid medium also acts as a heat transfer medium to remove heat from said core.

4. The apparatus of claim 1 or 2 wherein:
reactants are provided from a gaseous medium; and
the apparatus further comprises a thermally conductive mass of material thermally coupled to said core for transferring heat away from said core.

5. The apparatus of claim 1 or 2 wherein:
the apparatus further comprises a thermally conductive mass of material;
said core comprises core material disposed on a first surface of a thermally conductive mass of solid material; and
said thermally conductive mass of material provides a mechanism for transferring heat away from said core.

6. The apparatus of claim 5 wherein said thermally conductive mass of material has a surface portion in contact with a working fluid.

7. The apparatus of claim 1 or 2 wherein said mechanism for inducing phonons in the core comprises a sonic or ultrasonic actuator.

8. The apparatus of claim 1 or 2 wherein said mechanism for inducing phonons in the core comprises a heater.

9. The apparatus of claim 1 or 2 wherein said mechanism for inducing phonons in the core comprises a source of current pulses.

10. The apparatus of claim 1 or 2 wherein said core is formed as a wire or a sheet.

11. The apparatus of claim 1 or 2 wherein said core is formed as a fluidized or powder bed.

12. The apparatus of claim 1 wherein said mechanism for controlling the introduction of reactants into the core comprises an electric field generator.

13. A method for energy generation comprising:

providing a body, referred to as the core, of a material capable of phonon propagation;

introducing reactants into the core;

generating phonons in the core to provide energy for said reactants to undergo nuclear reaction; and

controlling the rate of reactant introduction and the rate of phonon generation so as to control the number of nuclear reactions and the depth of the nuclear reactions in the core so as to provide a desired level of energy generation while allowing energy released due to the nuclear reactions to dissipate in a manner that substantially avoids destruction of the core.

14. An apparatus for energy generation comprising:

a body, referred to as the core, of a material capable of phonon propagation;

a vessel for maintaining a liquid in contact with said core;

a controlled electrolysis source, electrically coupled to said core, for introducing reactants from said liquid into said core;

a pulse generator for establishing current pulses through said core, said current pulses generating phonons in said core so as to cause reactants in said core to undergo nuclear reactions; and

a control system, coupled to said electrolysis source and to said pulse generator, for controlling the number of nuclear reactions and the depth of the nuclear reactions in said core so as to provide a desired level of energy generation while allowing energy released due to the nuclear reactions to dissipate in a manner that substantially avoids destruction of said core.

15. An apparatus for energy generation comprising:

a body, referred to as the core, of a material capable of phonon propagation;

a vessel for maintaining a liquid in contact with said core;

a controlled electrolysis source, electrically coupled to said core, for introducing reactants from said liquid into said core;

an ultrasonic actuator, acoustically coupled to said core, for generating phonons in said core so as to cause reactants in said core to undergo nuclear reactions; and

a control system, coupled to said electrolysis source and to said ultrasonic actuator, for controlling the number of nuclear reactions and the depth of the nuclear reactions in said core so as to provide a desired level of energy generation while allowing energy released due to the nuclear reactions to dissipate in a manner that substantially avoids destruction of said core.

PATENT

Attorney Docket No.: 026063-000100US

ENERGY GENERATION APPARATUS AND METHOD

ABSTRACT OF THE DISCLOSURE

A practical technique for inducing and controlling the fusion of nuclei within a solid lattice. A reactor includes a loading source to provide the light nuclei which are to be fused, a lattice which can absorb the light nuclei, a source of phonon energy, and a control mechanism to start and stop stimulation of phonon energy and/or the loading of reactants. The lattice transmits phonon energy sufficient to affect electron-nucleus collapse. By controlling the stimulation of phonon energy and controlling the loading of light nuclei into the lattice, energy released by the fusion reactions is allowed to dissipate before it builds to the point that it causes destruction of the reaction lattice.

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David N. Stone (650) 326-2400
Townsend and Townsend and Crew LLP
Two Embarcadero Center, 8th Floor
San Francisco, CA 94111-3834

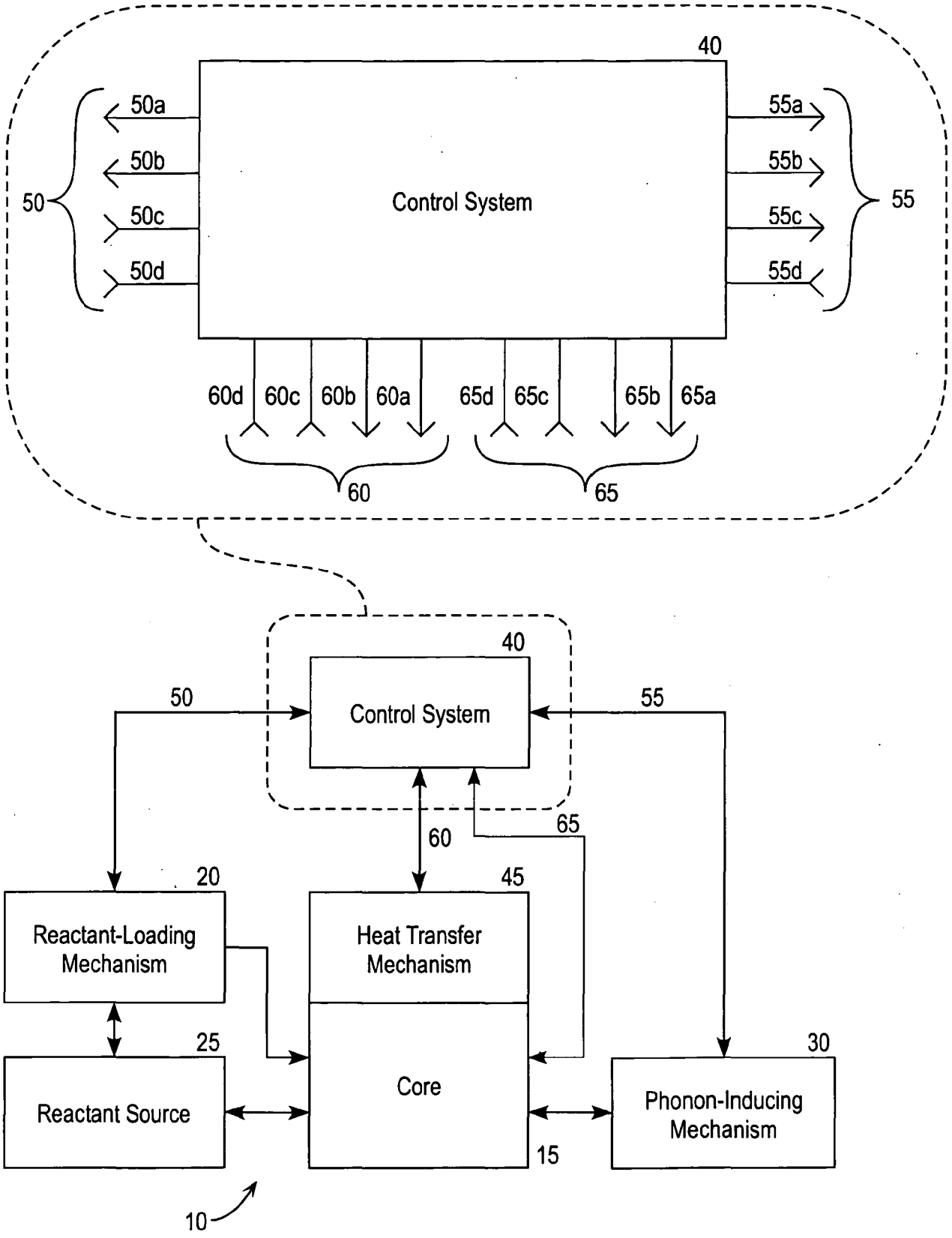

FIG. 1

High Level Schematic

David N. Slone (650) 326-2400
Townsend and Townsend and Crew LLP
Two Embarcadero Center, 8th Floor
San Francisco, CA 94111-3834

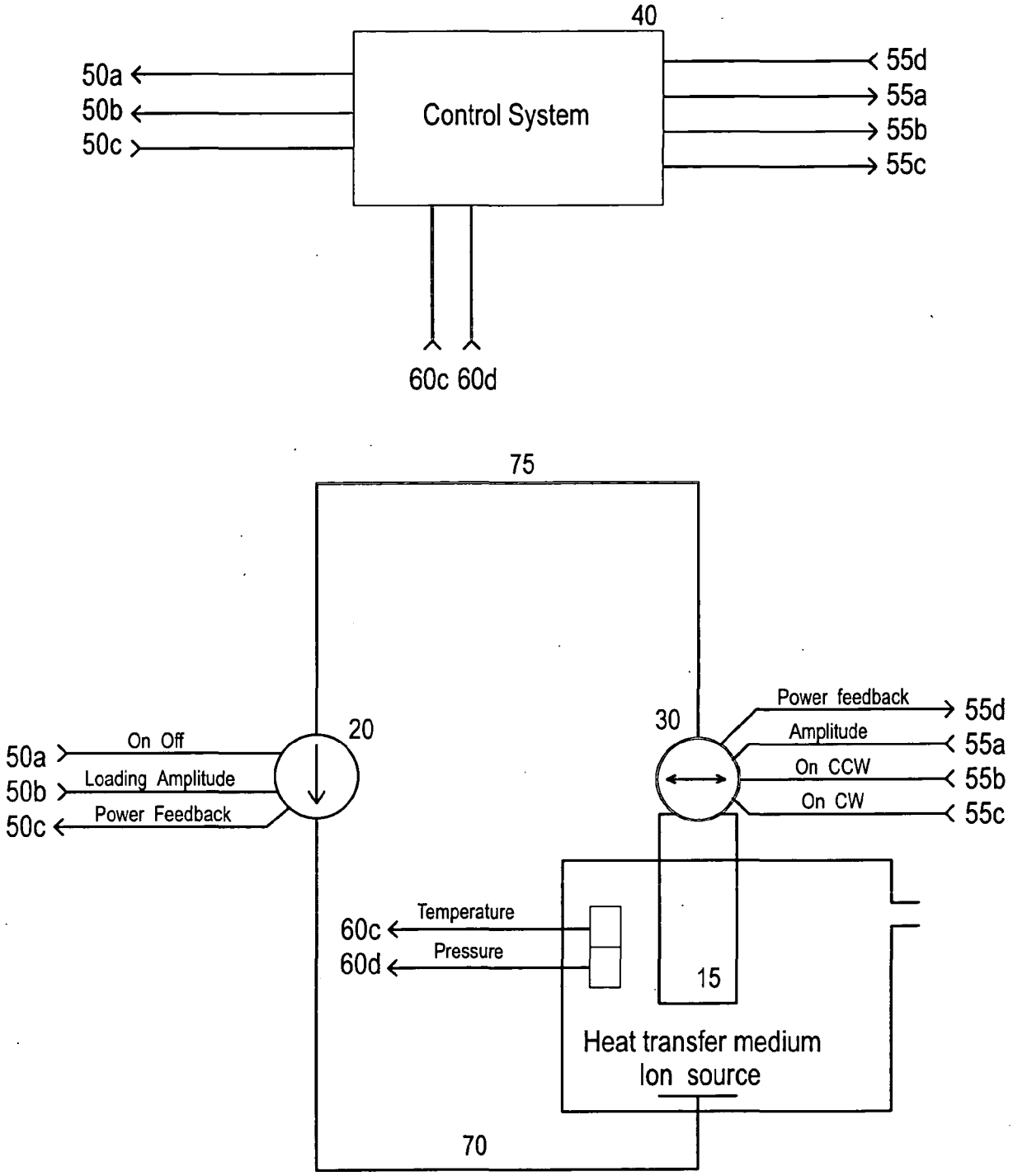

FIG. 2

David N. Stone (650) 326-2400
Townsend and Townsend and Crew LLP
Two Embarcadero Center, 8th Floor
San Francisco, CA 94111-3834

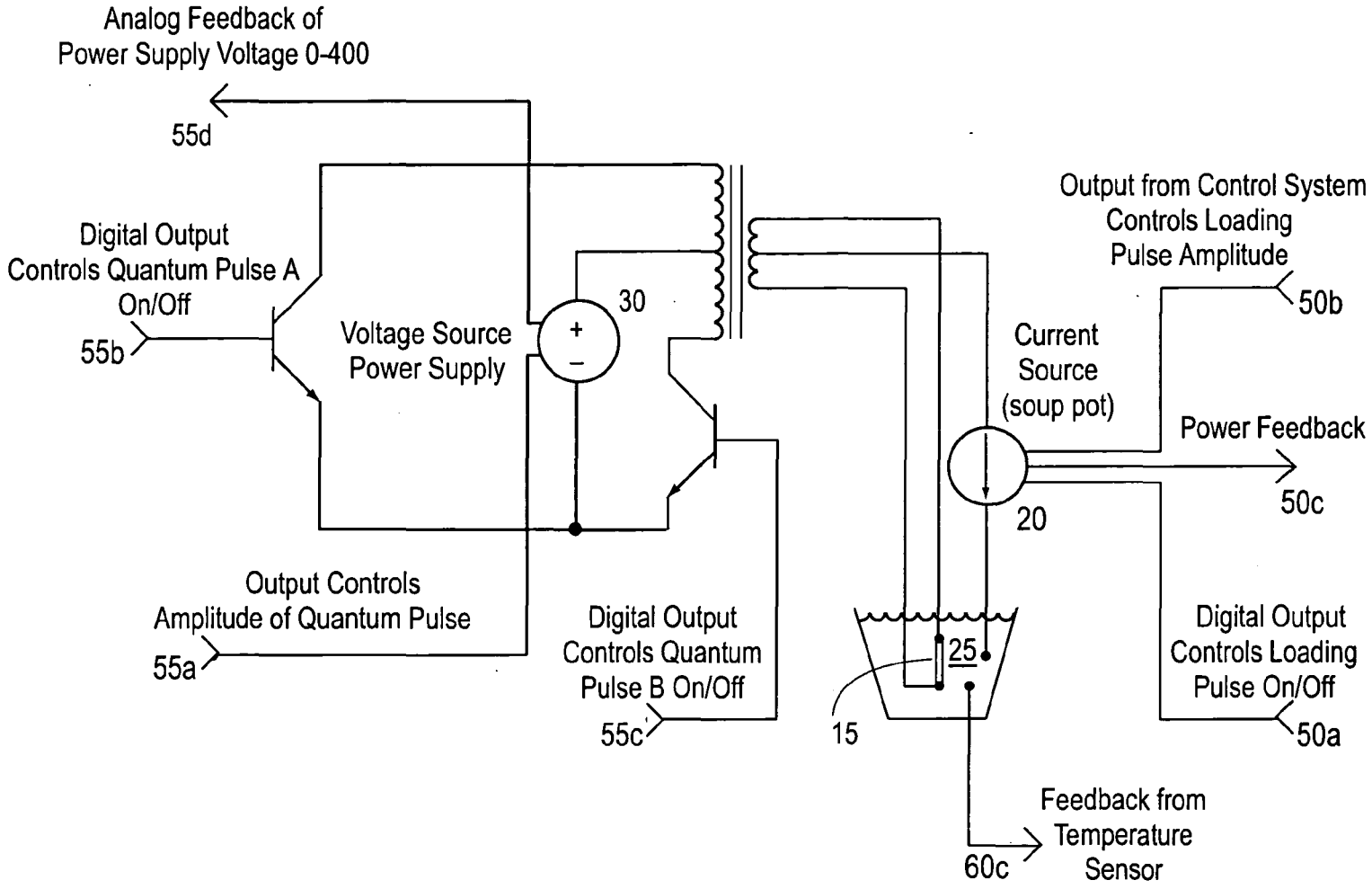

FIG. 3A

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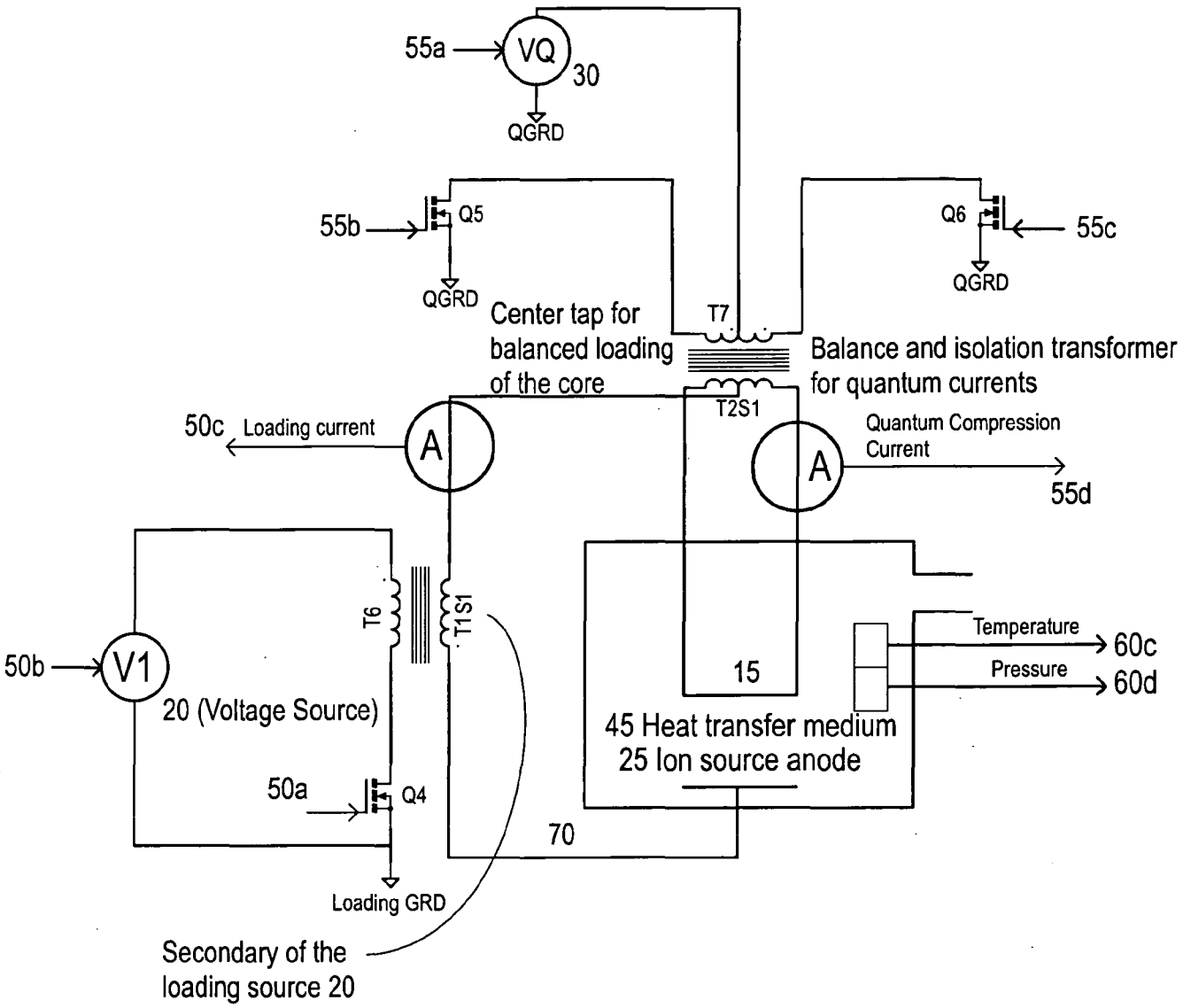

FIG. 3B

One Potential Implementation

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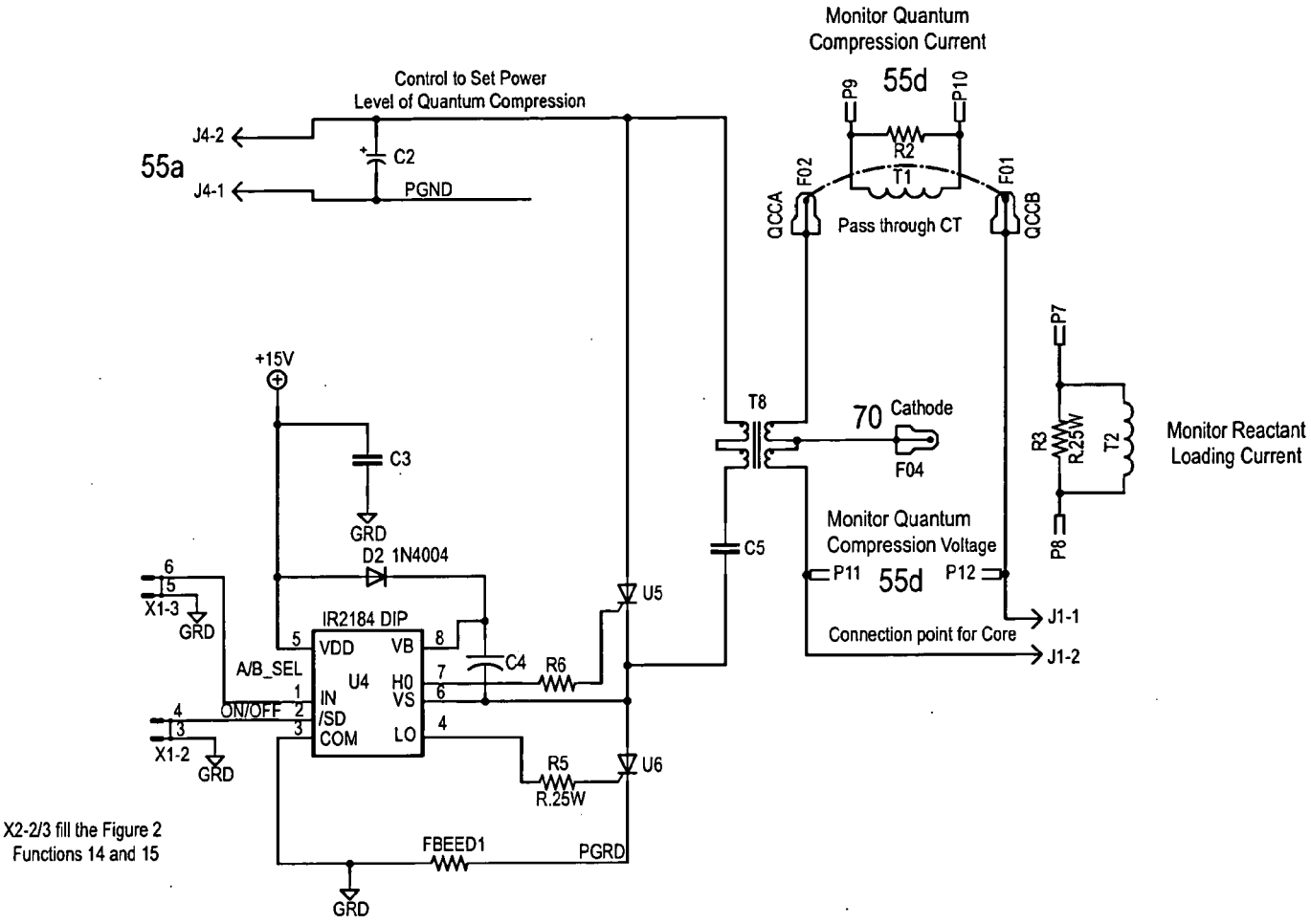

Note:
01) This page is one potential realization of FIG. 2 items 2, 6, 10 and 12 to 14.

02) QCC stands for Quantum Compression Current.

FIG. 3C

Compression Current Realization

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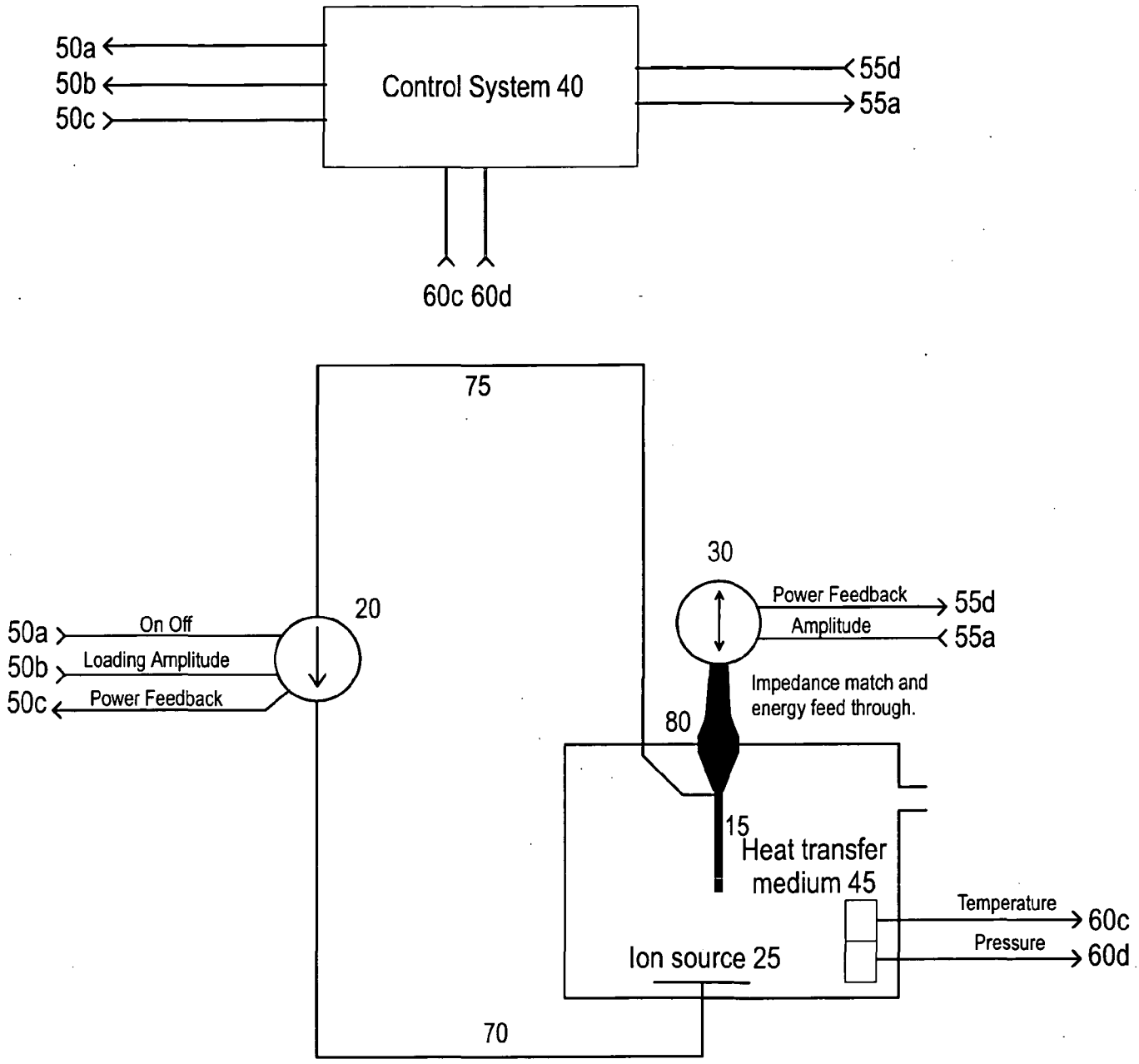

FIG. 4

Ultrasonic Implementation

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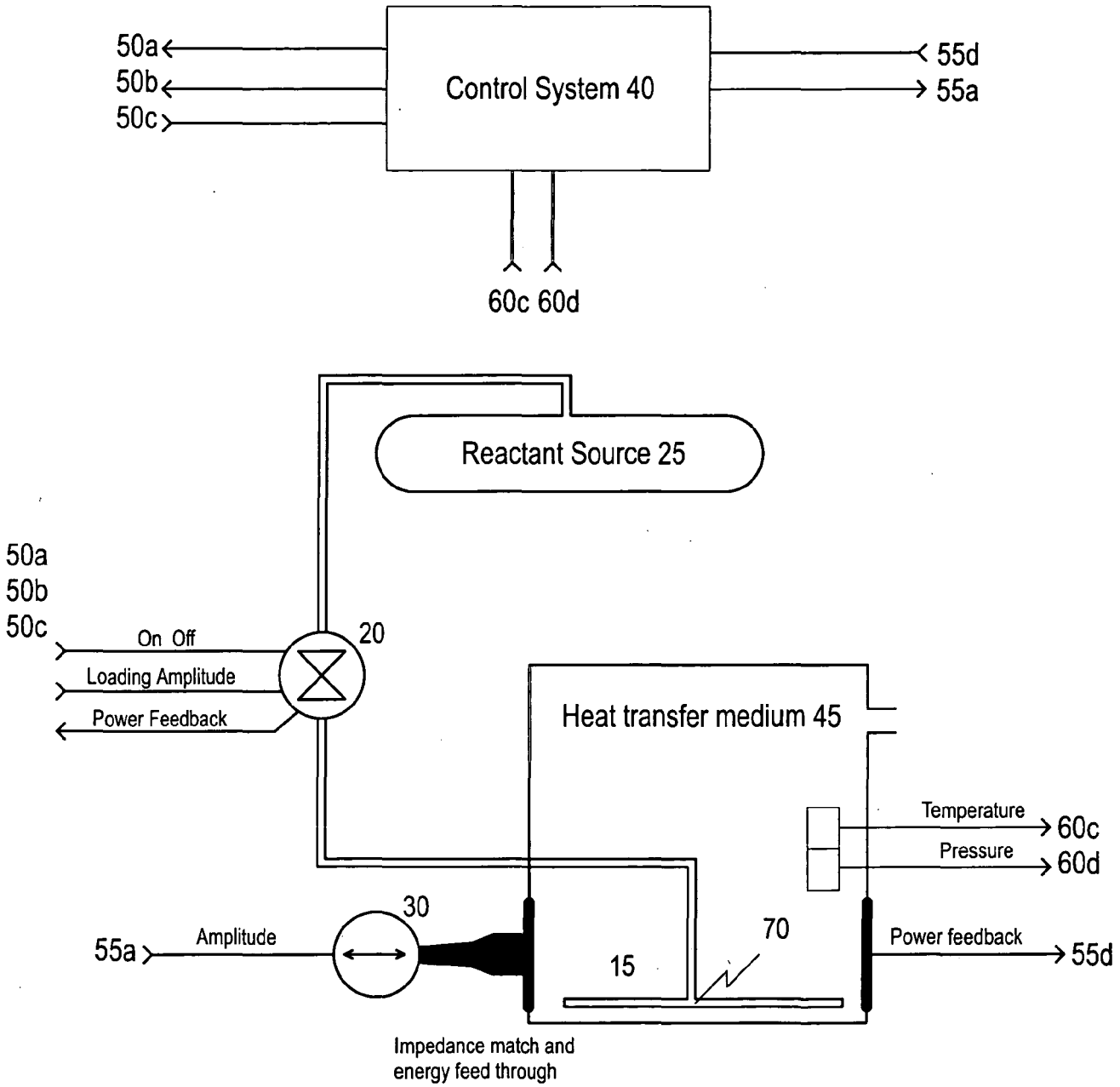

FIG. 5

Ultra Sonic Fluid Bed

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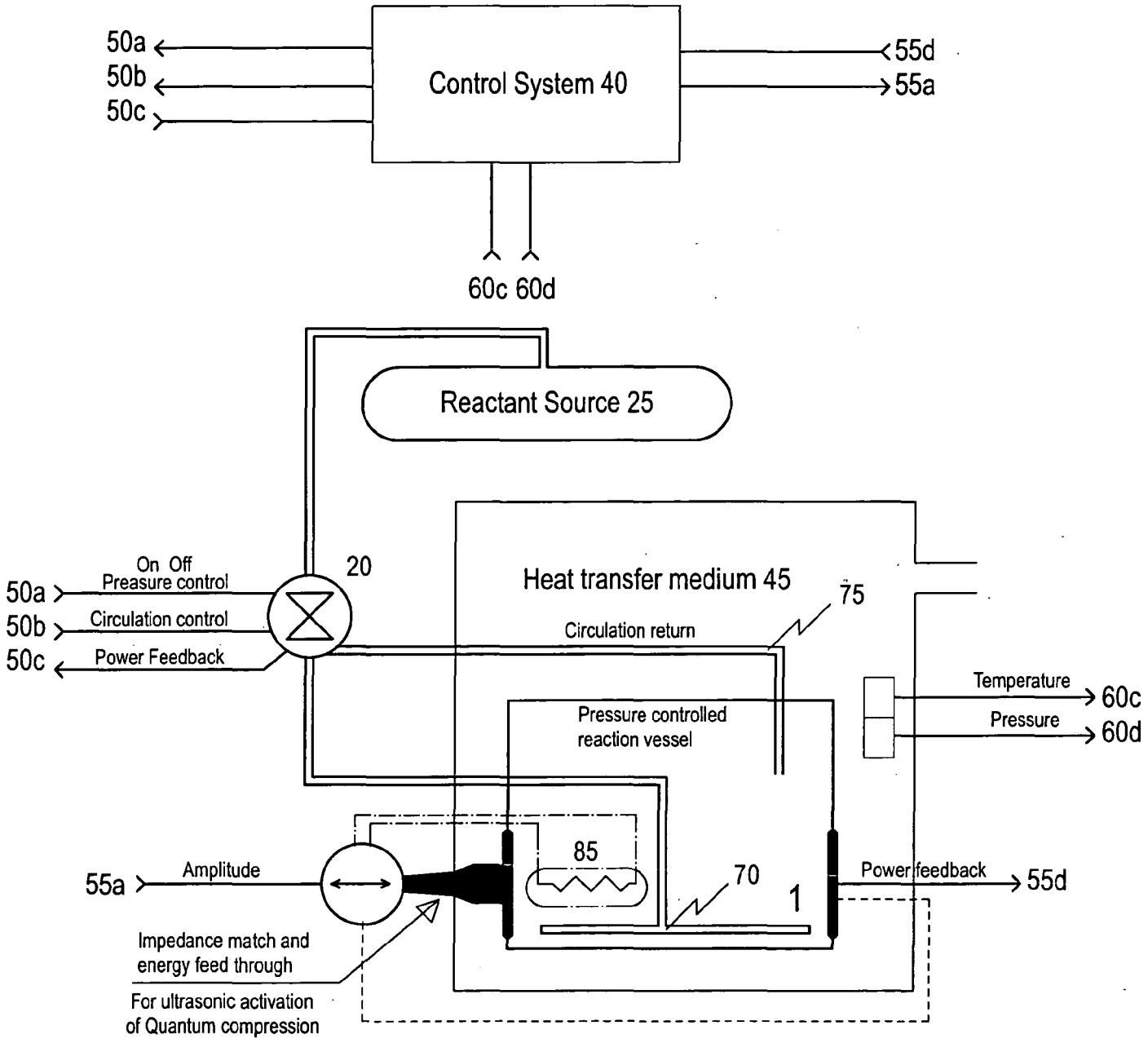

FIG. 6

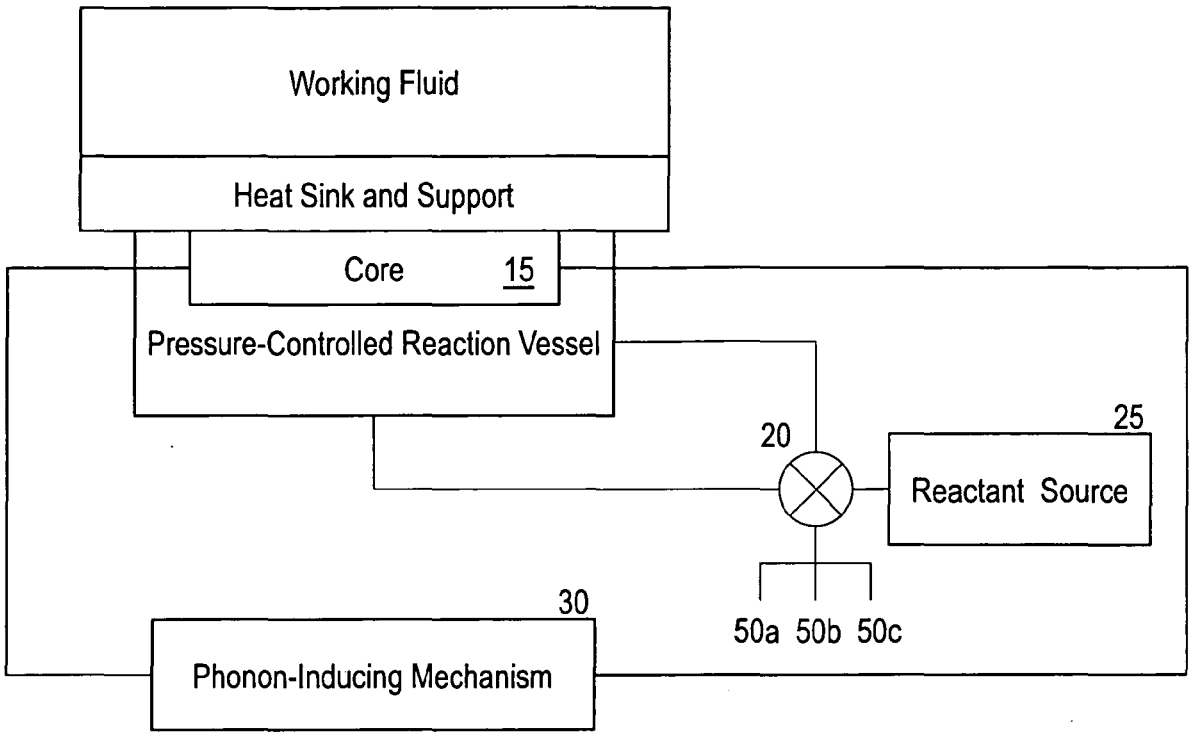

FIG. 7

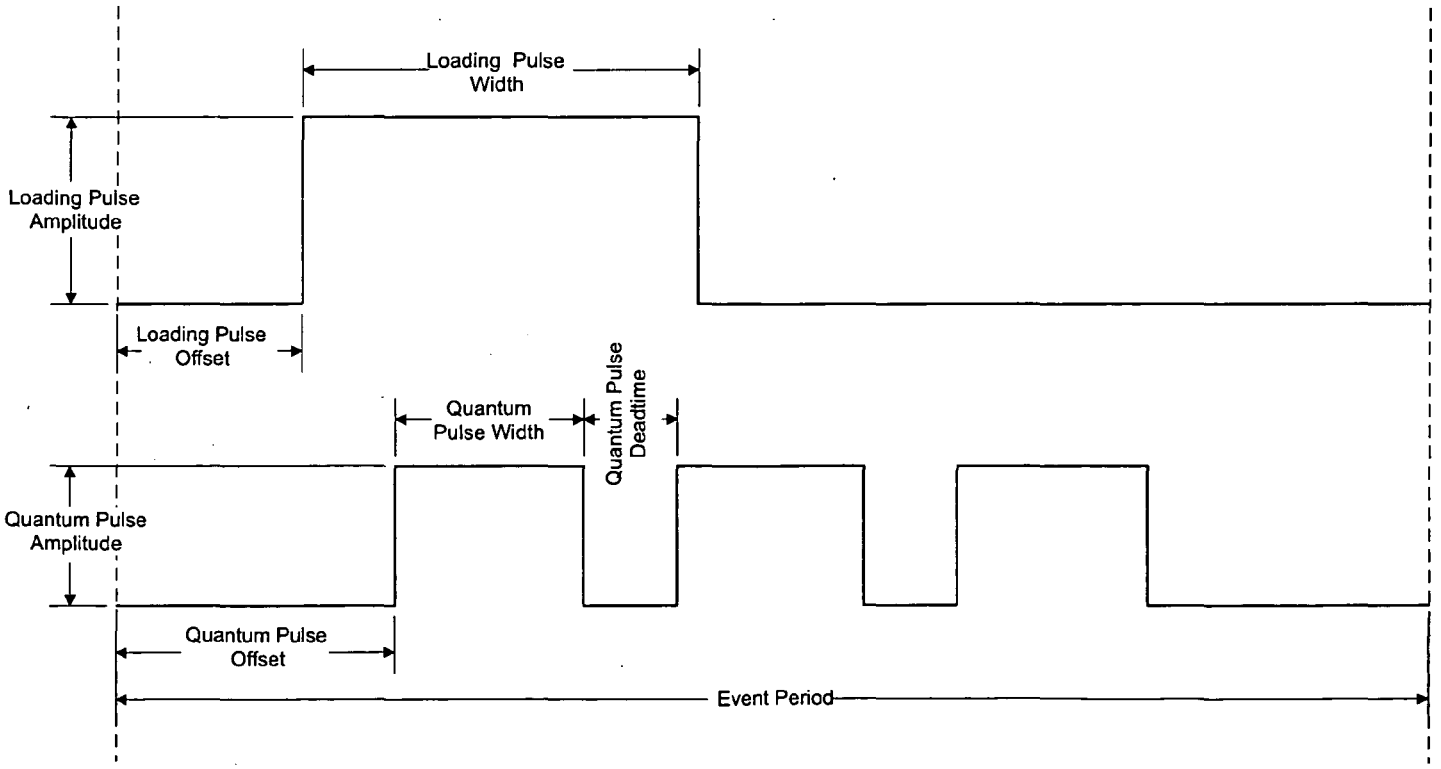

FIG. 8 Timing Diagram