(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
26 May 2011 (26.05.2011)

PCT

(10) International Publication Number
WO 2011/060523 A1

(51) International Patent Classification:
G21H 3/00 (2006.01) *G21D 3/08* (2006.01)
G21D 5/08 (2006.01) *H05H 7/06* (2006.01)

(21) International Application Number:
PCT/CA2009/001646

(22) International Filing Date:
19 November 2009 (19.11.2009)

(25) Filing Language: English

(26) Publication Language: English

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

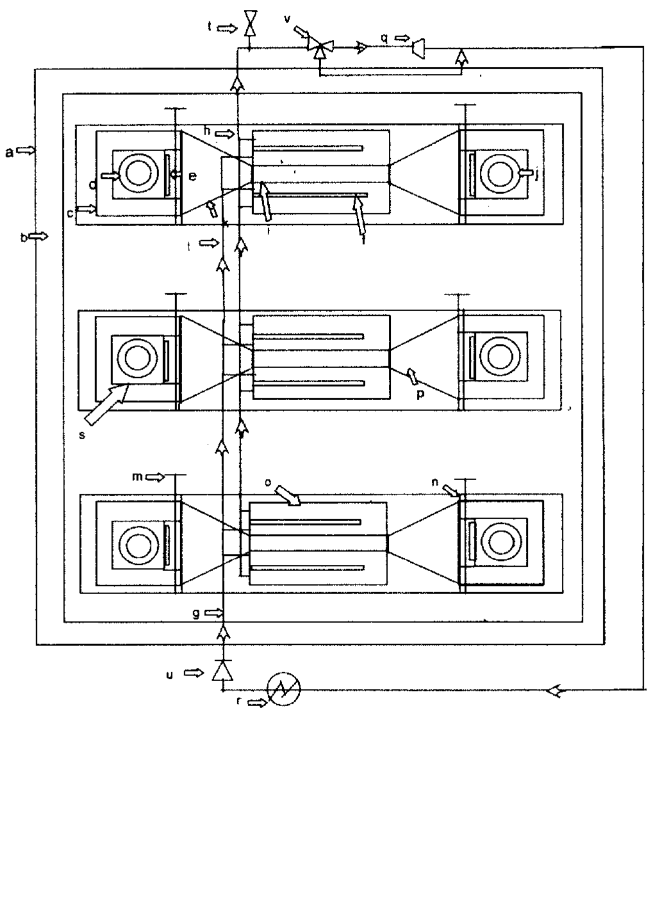
Declarations under Rule 4.17:
— *as to the identity of the inventor (Rule 4.17(i))*
— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

Published:
— *with international search report (Art. 21(3))*

[Continued on next page]

(54) Title: POSITRON - ELECTRON ANNIHILATION POWERED ENGINE

FIGURE 1
Positron-Electron Annihilation Fueled Turbine Engine - Staged Mounting Schematic and Flowsheet Diagram



(57) Abstract: The invention provides an energy generator fueled by the physical process of positron - electron annihilation to provide heat input to a closed thermal loop. A positron beam and an electron beam are obtained from any radioisotope sources that produce positrons or electrons as part of their nuclear decay process. The two beams are collimated and accelerated using a pair of conical solenoid coils, per Lorentz force, to collide the electron and positron beams in order to produce energy in the form of photons through positron - electron annihilation in a collision chamber. The heat produced by the annihilation process is then transferred into mechanical energy per Boyle's Law to drive a turbine or rotary engine with heated compressed gas in a closed thermal loop via thermosyphoning.

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— *with amended claims (Art. 19(1))*

POSITRON - ELECTRON ANNIHILATION POWERED ENGINE

The invention provides an energy generator fueled by colliding positrons and electrons, using the Lorentz force, in a collision chamber to produce photons and heat energy through positron - electron annihilation.

BACKGROUND OF THE INVENTION

The positron - electron annihilation process has long been understood in nuclear physics. To date, while particle collider reactors have been used to determine the positron - electron annihilation cross sections and energy, use of the process to drive mechanical engines has not been established.

This invention provides a positron - electron collider to produce energy to drive commercially available mechanical engines.

SUMMARY OF THE INVENTION

In the particularly advantageous embodiment of the invention considered broadly, positron - electron annihilation fueled generators, according to the invention, consist of positron and electron sources provided by the nuclear decay process of radioisotopes that yield positrons and electrons, and conical solenoid coils attached to a collision chamber to collide the positrons and electrons using the Lorentz force, to produce electromagnetic energy obtained from positron - electron annihilation in the collision process. Each individual positron - electron annihilation yields energy equal to the combined rest mass of a positron and an electron, on the order of 1 MeV. The electromagnetic energy obtained from the process is converted into mechanical energy by the heat-up of compressed gas per Boyle's Law, $PV = nRT$, and the established physics of black-body radiation where $E \propto kT^4$, and T is the collision reaction temperature obtained in the collider. The resulting increase in compressed gas pressure then drives a turbine or rotary engine (henceforth termed a turbine/rotary engine). A staged vertical mounting of the engine is provided to generate desired power outputs consistent with the limits of allowable heat stresses associated with the material properties of the engine and heat transfer properties and limits of the compressed gas coolant. Radiation shielding is provided for both the gamma and beta emissions of the radioisotope sources, and for gamma radiation emitted by the positron - electron annihilation process. The radiation shielding and engine mounting are dimensioned to meet all pertinent regulatory requirements, including those pertinent to transport of radioactive materials, of the International Atomic Energy Agency, and the regulatory requirements of other domestic nuclear regulators that are signatories to the IAEA Nuclear Safety Convention. The invention is also designed for compliance with ASME requirements for pressure retaining systems.

In the drawing, Figure 1, which forms part of this specification, a schematic layout of the engine arrangement is given displaying the engine mounting and shielding, the positron and electron emitter sources, the solenoid coils, and collision chamber to accelerate and collide positrons and electrons, the compressed gas heat transfer chamber, the location of the compressed gas turbine/rotary engine, and compressed gas heat exchanger. The compressed gas turbine/rotary engine is located above the collision chamber to support thermosyphoning of the compressed gas.

The solenoid coil current and number of windings, and source term aperture width, are dimensioned and electro-pneumatically coupled to match positron - electron flux density and annihilation reaction rate to meet demand power. The design of the turbine/rotary engine, heat exchanger, and the electro-pneumatic circuitry for engine power control, are not included in the drawing as these devices are already patented and/or are commercially available.

The source term, aperture, and power density of the collision chamber, are dimensioned so as not to exceed the thermal stress levels of the generator materials. Material selection for construction of the generator is based on the specific use and power levels intended for the generator, and takes into account thermal stress, corrosion resistance, pressure relief capacity, heat transfer coefficients and heat capacities to maximize the efficiency of power generation within the constraints of material tolerances. All domestic and international regulations pertaining to boilers and pressure vessels, including pressure relief, are taken into account with the dimensioning of the engine for each specific application for the intended power output.

The energy available for use as generated in the collision chamber, is given by the positron - electron annihilation cross-section (available in scientific literature) multiplied by the positron - electron flux density current in the collision chamber obtaining a reaction temperature T, providing a total mechanical heat flux given by $E \propto kT^4$. The heated compressed gas then flows through a closed circuit to the compressed gas mechanical turbine/rotary engine, and drives the engine on gas expansion per Boyle's Law, PV = nRT. The exhaust gas from the turbine/rotary engine is then cooled in a gas heat exchanger that is sized and dimensioned to reduce gas temperature to ambient conditions.

The compressed gas flow rate is driven by thermosyphoning which is proportional to the pressure gradient through the closed thermal loop.

DETAILED DESCRIPTION OF THE INVENTION

In the particularly advantageous embodiment of the invention illustrated in Figure 1, the positron - electron annihilation fueled engine is comprised of:

(a) Engine Mounting Casing dimensioned to fit and secure the body of the engine in a rigid geometrical array, including shielding for radiation. The engine mounting casing, including materials of construction, meets requirements for normal or accident conditions, including those described in the International Atomic Energy Agency regulations for transport of radioactive material, and including expected stress, and including transfer of excess waste heat from the engine to ambient conditions of the environment;

(b) Radiation shielding to limit radioactive dose rates at the surface of the engine mounting to <2.5 mrem/h;

(c) Shielded isotope source casings (henceforth termed as "source casings") as mountings for each of the positron and electron source radioisotopes, with key-locked lids to allow access for replacement of the sources, as necessary, with source term nuclear decay;

(d) Positron source emitter which includes any radioisotope that yields positrons with nuclear decay. Selection of the radioisotope is optimized for decay rate, and hence positron emission rate, of the source, versus the ½ -life of the source as needed for the intended application and energy load. Any radioisotope that yields positrons (i.e., β+ particles) with nuclear decay may be considered for selection as a positron source emitter;

(e) Apertures, affixed to a circular opening of the shielded source casing, (c), with an electro-pneumatically operated opening, comprised of materials that absorb positrons or electrons. The diametric opening is operated to control and limit the admittance and flux density of positrons and electrons to the solenoid coil and collision chamber;

(f) Baffle plate, in cylindrical configuration, to optimize exposure of compressed gas coolant to heat radiation generated in the collision chamber as a function of surface area of compressed gas exposed to heat input relative to the volume of gas in the compressed gas heat transfer chamber (o);

(g) Compressed gas inlet header providing compressed gas flow from the outlet of the heat exchanger, (r), to the compressed gas heat transfer chamber (o);

(h) Compressed gas outlet providing outflow from the compressed gas heat transfer chamber to the compressed gas outlet header, (u);

(i) Positron - electron coil cylindrical collision chamber, (henceforth, collision chamber) with electrically conductive windings on a non-magnetic electrically conductive material to generate an electromagnetic field to direct and collide positrons and electrons admitted to the chamber by conical solenoid coil assemblies (k). (Note that positrons and electrons admitted to the same electromagnetic field, as in the collider, will travel in opposite directions and be attracted to each other, per the Lorentz force);

(j) Electron source emitter which includes any radioisotope that yields electrons with nuclear decay. Selection of the isotope is optimized for decay rate, and hence electron emission rate, of the source, versus the ½ - life of the source for the intended application and energy load. Any radioisotope that yields electrons (i.e., β^- particles) with nuclear decay may be selected as a source emitter;

(k) Conical solenoid coil assemblies, with electrically conductive windings on a non-magnetic electrically conductive material, in conical configuration, that collimate and accelerate positrons and electrons to admit the particles to the inputs at either end, respectively, of the collision chamber (i) ;

(l) Compressed ideal gas coolant that may include any non-combustive ideal gas selected for optimal operating pressures, heat transfer coefficients and heat capacities suitable for the intended mechanical load. The specific gas selected for the intended application should have ideal gas properties, and maximal heat transfer coefficients with sufficient heat capacity to absorb heat energy generated by the positron - electron annihilation process for rapid heat-up of the gas, followed by rapid cooling of the gas in the turbine/rotary engine through gas expansion in the turbine/rotary engine. The gas selected is inert to combustion or deflagration. The compressed gas flow inertia is determined by thermosyphoning of the closed thermal loop;

(m) Interlock device for secure source replacement by licensed supplier/service agent. The interlock disconnects the source casing from the engine while preserving the engine vacuum, (p) at specification;

(n) Interlock vacuum seals for source replacement to ensure vacuum is maintained at operating specification;

(o) Compressed gas heat transfer chamber designed to permit maximal heat transfer to compressed gas from the collision chamber. Materials are chosen for the compressed gas chamber for expected thermal and mechanical stresses;

(p) Vacuum to minimize particle collisions other than those between positrons and electrons;

(q) Compressed gas driven turbine or rotary engine (henceforth, “turbine/rotary engine”) located in the closed thermal loop and driven by heated compressed gas coolant (l), in the closed thermal loop, with a currently commercially available turbine/rotary engine (not included in this claim);

(r) Heat exchanger dimensioned to reduce maximum compressed gas temperature to ambient temperature;

(s) Cylindrical solenoid coils within shielded source casings, (c), to provide admittance of positrons and electrons to the conical solenoid coil assemblies, (k), and the positron - electron collision chamber;

(t) Overpressure relief valve with setpoints specified to open when gas pressure exceeds 115% of the design pressure of the closed thermal loop. The valve is located between the collision chamber outlet and the inlet to the turbine/rotary engine;

(u) Compressed gas outlet header and check valve.

(v) Three-way control valve to control heated compress gas flow to the turbine/rotary engine inlet to meet engine demand load, with excess compressed gas bypassed to heat exhanger, (r).

It will be apparent that various engine dimensions and sizings may be specified based on the intended load for the turbine/rotary engine. The dimensions and sizings are specified to meet the specific intended mechanical load of the engine by application of the following equations:

1. The power density produced by the positron - electron annihilation reaction is given by $\mathscr{P} = j_{e,p}\, \sigma_{e,p} E_{e,p}$, where $j_{e,p}$ is positron - electron flux density current, $\sigma_{e,p}$ is the positron - electron annihilation cross section, and $E_{e,p}$ is the energy released per annihilation.

2. Lorentz force, $\mathbf{F} = q(\mathbf{E} + \mathbf{vxB})$, and the Biot-Savart Law, where $q = \pm e$ according to the charge of the positron and electron respectively. The Lorentz force determines the direction and energy level of the non-collided positrons and electrons on admittance to the positron - electron collision chamber, with the positron and electron population at either end of admittance to the collision chamber acting as cathode and anode respectively. The positrons and electrons will travel in opposing helical paths along the coil axes. The cylindrical form of the collision chamber yields a magnetic induction, B, given by:

$$B = \frac{\mu_0 NI,}{2\pi\rho}$$

where N is the total number of windings around the non-magnetic material of the coil collision chamber, and I is the electrical current through the windings, and ρ is the radial distance from the coil collision chamber surface to points of the positron - electron flux distributed along the axis of the coil. The term $q(\mathbf{E} + \mathbf{vxB})$, including the electric field of the charged positrons and electrons, are then determined by the number of windings and voltage drop to impart sufficient kinetic energy to the positron and electron particle beams to maximize $\sigma_{e,p}$, the positron - electron annihilation cross-section, which is a function of the kinetic energy of the positron and electron particles.

3. The usable energy for mechanical loading is given by $E \propto kT^4$, established for black body radiation, where T is the positron - electron reaction temperature.

4. Heat transfer across boundaries such as the collision chamber and compressed gas chamber and gas is given by: $P_{heat} \propto k_h \Delta T$, where k_h is the heat transfer coefficient of the boundary material.

5. Thermosyphoning drive of the compressed gas flow rate is determined by the temperature and pressure gradient of the compressed gas around the loop. The characteristic magnitude of the compressed gas pressure drop across the turbine/rotary engine and the heat exchanger must be equal to the pressure gain across the collision chamber. The characteristic pressure drops across the commercially available turbine/rotary engine and heat exchanger are included in manufacturing specifications for the devices. The mechanical power output is given by $\mathscr{P}_{mech} = \frac{d}{dt} \oint C_v(T,\rho)$ where C_v is the temperature dependent heat capacity of the gas as a function of compressed gas density. The remainder of the dimensional and sizing specifications of the positron - electron annihilation fueled engine are determined by conservation of energy. The operating pressures of the thermal loop are determined by the inlet pressure and pressure drop listed in the specifications of the turbine/rotary engine selected for application. This, by reason of application of the above equations, determines the sizing and dimensioning of the entire invention.

6. The dimensions of the positron - electron collision chamber are determined by the mean free path of the positron in a flux of electrons given by:

$$\lambda(E) = (\Sigma\, j_{e,p} \times \sigma_{e,p})^{-1}$$

so that the length of the collision chamber is given by:

$$L = \mathscr{P}_{max} \frac{\lambda(E)}{E_{e,p}}$$

and the cross-sectional area of the collision chamber is given by:

$$A = \frac{\mathcal{P}_{max}}{j_{e,p(max)} L \, E_{e,p}}$$

where $E_{e,p}$ = 1MeV (energy released per annihilation), $\sigma_{e,p}$ is the positron - electron annihilation cross section given in scientific literature, $j_{e,p}$ is the flux density of positrons or electrons through the collider from the radioactive sources, and $\mathcal{P}_{max}$ is the maximum demand power output. The mean free path of a positron in a flux of electrons resulting in positron - electron annihilation, is available in scientific literature in formulaic form.

Method of operation:

This provides a brief description of the operation of the subject invention.

With the apparatus of the above description, energy is produced by colliding collimated beams of positrons and electrons introduced into a collision chamber. The respective positron and electron beams are accelerated in opposing directions within the collision chamber by the action of Lorentz's Law for electromagnetic fields generated by using solenoid coils to collimate and accelerate opposing beams of positrons and electrons through a collision chamber. The flux density of positrons and electrons through the solenoid coils and collision chamber is limited by electro-pneumatic opening and closing of apertures on the source casings of the positron and electron source emitters, with the apertures fully open in normal condition, and with the apertures fully closed for engine shutdown and maintenance. Power output of the turbine/rotary engine is controlled by operation of a three-way control valve to bypass excess compressed gas around the turbine/rotary engine as needed to meet demand load. Collision of the positron and electron beams results in the production of energy obtained with the process of annihilation process of positron - electron collision, heat from which is transferred to a closed-loop compressed gas thermosyphoning heat cycle to drive a or turbine engine.

DRAWINGS

Figure 1: Positron - Electron Annihilation Fueled Turbine/Rotary Engine - Staged Mounting Schematic and Flowsheet Diagram

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

We claim:

1. An electron-positron collision apparatus for generation of heat energy by annihilation process of positron - electron collision, comprising: a positron source emitter consisting of radioisotopes that yield positrons in nuclear β^+ decay processes; a electron source emitter consisting of radioisotopes that yield electrons in nuclear β^- decay processes; two cubic source casings, one for said positron source emitter and one for said electron source emitter; a cylindrical solenoid coil mounted within each of two said source casings (henceforth, "source casing") and with respective said positron source emitter and said electron source emitter mounted within said cylindrical solenoid coils respectively; the center of mass of each said positron source emitter and said electron source emitter lie on the respective longitudinal center axes of said cylindrical solenoid coils, respectively; a circular opening through one side each of said source casings; both said circular openings have equal diameters; the centers of each of two said circular openings lie on the respective longitudinal center axes of said cylindrical solenoid coils mounted as said within said source casings; the diameters of said openings are at least equal to the maximum diametral length of a cross section of said positron source emitter and said electron source emitter, respectively, and the diameters of said openings are equal to the inner diameter of each said cylindrical solenoid coil; each of two said circular openings is fitted with a circular aperture attached concentrically with said circular openings, where said apertures have outer diameter equal to the inner diameter of said circular openings; the large radius end of first of two conical solenoid coils is attached to the exterior of one side of one of said shielded isotope source casing of said positron source emitter, with said aperture abutted to, and aligned concentrically with the longitudinal axis of the open face of the large radius end of said first of two conical solenoid coils; the large radius end of second of two conical solenoid coils is attached to the exterior of one side of second of said shielded isotope source casing for said electron source emitter, with said aperture abutted to, and aligned concentrically with the longitudinal axis of the large radius end of said second of two conical solenoid coils; both said conical solenoid coils are comprised of electrically conductive windings on a non-magnetic electrically conductive material to generate a electromagnetic field along the longitudinal axis of said conical solenoid coils, per Lorentz's Law; the large radius ends of both said conical solenoid coils have radii equal to the radius of the fully opened said apertures; the small radii ends of two said conical solenoid coils are attached respectively to either end of a cylindrical collision chamber; the inner radius of said cylindrical collision chamber is equal to the inner

radius of the small radius ends of said conical solenoid coils; said first conical solenoid coil is aligned concentrically along its longitudinal axis with the longitudinal axis of said collision chamber which in turn is aligned concentrically along the longitudinal axis of said second conical solenoid coil; a vacuum is provided within the combined internal volume of the attached said isotope source casings, said conical solenoid coils and said cylindrical collision chamber; both said apertures are electro-pneumatically operated to limit and control the admittance, and flux density, of positrons and electrons provided by respective said positron source emitter and said electron source emitter through internal volume of respective said cylindrical solenoid coils mounted within said source casings, then through respective said apertures to within the open face of the large radius ends of said conical solenoid coils; said conical solenoid coils collimate and accelerate positrons and electrons, respectively, produced by nuclear decay processes of said positron source emitter and said electron source emitter, through the interior volume of said conical solenoid coils, in opposing directions into opposite ends, and into the interior, of said collision chamber in which said positrons and said electrons are accelerated and collided per Lorentz's Law by using an electromagnetic field generated in the interior of said conical solenoid coils and said collision chamber; a compressed gas heat transfer cylindrical chamber with the inner cylindrical wall of said compressed gas heat transfer chamber (henceforth "heat transfer chamber") attached concentrically with, and along the longitudinal axis of, said collision chamber; the inner diameter of said heat transfer chamber is equal to the outer diameter of said collision chamber; said heat transfer chamber is composed of materials selected for optimum heat transfer coefficient and structural integrity and containing compressed gas coolant which gas coolant may be selected from any available non-combustible ideal gas for optimum operating pressures, heat transfer coefficients and heat capacities; heat generated by the positron - electron annihilation process in said collision chamber is transferred to said compressed gas contained in said heat transfer chamber; a compressed gas inlet header is connected by piping between said heat transfer chambers and the outlet of a heat exchanger (where the design of said heat exchanger is not included within the subject of this claim) to admit cooled compressed gas from the outlet of said heat exchanger to inlet of said heat transfer chamber; the inlet to said heat exchanger is connected via piping to the compressed gas exhaust of a turbine/rotary engine (where said design of turbine/rotary engine is not included in the subject of this claim); a compressed gas outlet header is attached via piping to the outlet of said heat transfer chamber, and is connected via piping to the inlet of said turbine/rotary engine in order to conduct heated compressed gas from said heat transfer chamber to inlet of said turbine/rotary engine; said piping to the inlet of said turbine/rotary engine includes a three-way control valve to control compressed gas flow to said turbine/rotary engine to meet turbine/rotary engine demand load and to direct excess compressed gas flow to bypass said turbine/rotary engine to compressed gas exhaust from said turbine/rotary engine; the inlets and outlets of said heat transfer chamber are selected at the loci of said heat transfer chamber that result in maximum fluid and heat flow rate in the given configuration through said heat transfer chamber; a baffle plate may be dimensioned and included within the said heat transfer chamber to maximize heat transfer to said compressed gas by increasing the surface area of exposure of said compressed gas to heat produced in said collision chamber; compressed gas exhaust from said turbine/rotary engine is directed through piping connected between said turbine/rotary engine exhaust and the inlet of said heat exchanger to complete a closed thermal circuit; a sub-assembly consisting of said source casings, said positron source emitter, said electron source emitter, said cylindrical solenoid coils, said conical solenoid coils, and said heat transfer cylindrical chamber are mounted within an engine mounting casing dimensioned to fit and secure the body of the engine in a rigid geometrical array; said engine mounting casing includes shielding materials to meet the requirements of the International Atomic Energy Agency Regulations and the regulations of domestic regulators for the nuclear power generation of those countries in which the engine of this claim is applied; said engine mounting may include a staged mounting of more than one said sub-assembly connected through piping connected from said heat transfer chambers of each said sub-assembly to one said compressed gas inlet header and one said compressed gas outlet header, with both said inlet header and outlet headers located exterior to said engine mounting casing; said compressed gas inlet header and said compressed gas outlet header, said turbine/rotary engine, and said heat exchanger are all securely mounted outside said engine mounting casing, with said piping connections between said inlet header said outlet header and said heat transfer chamber made through piping penetrations in the wall of said engine mounting casing; included as an integral part of said piping is a check valve located in said piping between said heat exchanger and said inlet header to prevent reverse flow of compressed gas from said compressed gas inlet header to said heat exchanger.

2. A vacuum is provided in the internal volume of the assembly of the said shielded isotope source casing, said solenoid coils and said collision chamber from Claim 1.

3. Said aperture and said electronic/pneumatic aperture control from Claim 1, are specified to open and close said aperture to limit or shutdown admission electrons and positrons to said solenoid coils for purposes of engine shutdown and maintenance.

4. Said compressed gas contained in the combined internal volume of said heat transfer chamber, said outlet header, said piping, said turbine/rotary engine, said heat exchanger, and said inlet header, all of Claim 1, drive the said turbine/rotary engine through the process of thermosyphoning and gas expansion per Boyle's Law; where heat input to said compressed gas is provided by the thermal energy of positron - electron annihilation process in said collision chamber, and where said heat input is given by the established equation for black-body radiation (i.e., $E \propto kT^4$).

5. Said shielded isotope source casing from Claim 1, includes shielding material together with a key interlock to allow replacement of said positron source emitter and said electron source emitter to meet and minimize radioactive dosage obtained in the course of replacement of said source emitters.

6. Said positron source emitter and said electron source emitter of Claim 1 are specified to provide the maximum positron and electron emission source terms available for positron-electron annihilation processes within said collision chamber that may be obtained to achieve the maximum said heat input by the positron-electron annihilation processes that occur within said collision chamber, where said maximum heat input by the positron - electron annihilation processes is within the heat transfer capacity of said compressed gas and said assembly of Claim 4. Included with the specification of said positron source emitter and said electron source emitter is the geometrical sizing of said source emitter to minimize self-shielding due to nuclear absorption of the source positrons and electrons by said source emitters themselves. The power density produced by the positron - electron annihilation reaction is given by $\mathcal{P} = j_{e,p}\ \sigma_{e,p} E_{ep}$, where j is electron-positron flux density current, $\sigma_{e,p}$ is the electron-positron annihilation cross section, and E_{ep} is the energy released per annihilation. The dimensions of said collision chamber are determined by the mean free path of the positron in a flux of electrons given by:

$$\lambda(E) = (\Sigma\ j_{e,p} \times \sigma_{e,p})^{-1}$$

so that the length of said collision chamber is given by:

$$L = \frac{\mathcal{P}_{max}\ \lambda(E)}{E_{e,p}}$$

and the internal cross-sectional area of said collision chamber is given by:

$$A = \frac{\mathcal{P}_{max}}{j_{e,p(max)} L\, E_{e,p}}$$

where E_{ep} = 1MeV (energy released per positron - electron annihilation event), $\sigma_{e,p}$ is the positron - electron annihilation cross section given in scientific literature, $j_{e,p}$ is the flux density of positrons or electrons in said collision chamber from the radioactive sources. $\mathcal{P}_{max}$ is chosen to meet the maximum demand power load for the intended application. The mean free path of a positron in a flux of electrons resulting in positron - electron annihilation, is also available in scientific literature in formulaic form.

7. The maximum pressure of the said compressed gas, per Claim 4, is set to optimize heat transfer properties of the gas to support thermosyphoning to meet the intended mechanical load of the said turbine/rotary engine while meeting the ASME Code and domestic code requirements for pressure vessels.

8. A pressure relief system including pressure relief valves are provided as an intrinsic part of the assembly of the said compressed gas heat transfer chamber, said inlet header, said piping, said turbine/rotary engine, and said heat exchanger, all of from Claim 4, to meet the ASME Code and domestic code requirements for pressure vessels.

9. Said turbine/rotary engine of Claim 1 is mounted at higher elevation with respect to said engine mounting casing to support and maximize the thermosyphoning flow of the compressed gas.

10. Said heat exchanger of Claim 1 is mounted at lower elevation with respect to said engine mounting casing of Claim 1 to support and maximize the thermosyphoning flow of said compressed gas.

11. The electromagnetic field energy provided by said solenoid coils and said collision chamber, from Claim 1, is optimized for: the cross-section of positron - electron annihilation where said cross-section is a function of the kinetic energy of the positrons and electrons, the positron - electron flux density within the collision chamber; and the electrical energy input to said solenoid coils and said collision chamber, to produce optimum net power generation of the said apparatus of Claim 1.

12. Said baffle plate may be dimensioned and installed in cylindrical configuration in said heat transfer chamber of Claim 1 to maximize exposure of compressed gas coolant to heat radiation generated in the collision chamber as a function of surface area of compressed gas exposed to heat input relative to the volume of gas in said compressed gas heat transfer chamber, while minimizing the compressed gas chamber length dimensions relative to said collision chamber dimensions.

13. An interlock device is provided with the attachment of said emitter source casings and said cylindrical solenoid coils, to allow removal and replacement of said source emitters contained in said source emitters casings, of Claim 1, and where the interlock key is held by a licensed supplier/service agent. The interlock disconnects said source casing from said conical solenoid coil while preserving the engine vacuum.

14. Interlock vacuum seals are attached at the interface of said conical solenoid coils and said emitter source casings of Claim 1, to ensure vacuum is maintained at operating specification.

AMENDED CLAIMS
received by the International Bureau on
19 November 2010 (19.11.2010)

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

We claim:

1. An electron-positron collision apparatus for generation of heat energy by annihilation process of positron - electron collision, comprising: a positron source emitter consisting of radioisotopes that yield positrons in nuclear β^+ decay processes; an electron source emitter consisting of radioisotopes that yield electrons in nuclear β^- decay processes; two cubic source casings, one for said positron source emitter and one for said electron source emitter; a cylindrical solenoid coil mounted within each of two said source casings (henceforth, "source casing") and with respective said positron source emitter and said electron source emitter mounted within said cylindrical solenoid coils respectively; the center of mass of each said positron source emitter and said electron source emitter lie on the respective longitudinal center axes of said cylindrical solenoid coils, respectively; a circular opening through one side each of said source casings; both said circular openings have equal diameters; the centers of each of two said circular openings lie on the respective longitudinal center axes of said cylindrical solenoid coils mounted as said within said source casings; the diameters of said openings are at least equal to the maximum diametral length of a cross section of said positron source emitter and said electron source emitter, respectively, and the diameters of said openings are equal to the inner diameter of each said cylindrical solenoid coil; each of two said circular openings is fitted with a circular aperture attached concentrically with said circular openings, where said apertures have outer diameter equal to the inner diameter of said circular openings; the large radius end of first of two conical solenoid coils is attached to the exterior of one side of one of said shielded isotope source casing of said positron source emitter, with said aperture abutted to, and aligned concentrically with the longitudinal axis of the open face of the large radius end of said first of two conical solenoid coils; the large radius end of second of two conical solenoid coils is attached to the exterior of one side of second of said shielded isotope source casing for said electron source emitter, with said aperture abutted to, and aligned concentrically with the longitudinal axis of the large radius end of said second of two conical solenoid coils; both said conical solenoid coils are comprised of electrically conductive windings on a non-magnetic electrically conductive material to generate a electromagnetic field along the longitudinal axis of said conical solenoid coils, per Lorentz's Law; the large radius ends of both said conical solenoid coils have radii equal to the

radius of the fully opened said apertures; the small radii ends of two said conical solenoid coils are attached respectively to either end of a cylindrical collision chamber; the inner radius of said cylindrical collision chamber is equal to the inner radius of the small radius ends of said conical solenoid coils; said first conical solenoid coil is aligned concentrically along its longitudinal axis with the longitudinal axis of said collision chamber which in turn is aligned concentrically along the longitudinal axis of said second conical solenoid coil; a vacuum is provided within the combined internal volume of the attached said isotope source casings, said conical solenoid coils and said cylindrical collision chamber; both said apertures are electro-pneumatically operated to limit and control the admittance, and flux density, of positrons and electrons provided by respective said positron source emitter and said electron source emitter through internal volume of respective said cylindrical solenoid coils mounted within said source casings, then through respective said apertures to within the open face of the large radius ends of said conical solenoid coils; said conical solenoid coils collimate and accelerate positrons and electrons, respectively, produced by nuclear decay processes of said positron source emitter and said electron source emitter, through the interior volume of said conical solenoid coils, in opposing directions into opposite ends, and into the interior, of said collision chamber in which said positrons and said electrons are accelerated and collided per Lorentz's Law by using an electromagnetic field generated in the interior of said conical solenoid coils and said collision chamber; a compressed gas heat transfer cylindrical chamber with the inner cylindrical wall of said compressed gas heat transfer chamber (henceforth "heat transfer chamber") attached concentrically with, and along the longitudinal axis of, said collision chamber; the inner diameter of said heat transfer chamber is equal to the outer diameter of said collision chamber; said heat transfer chamber is composed of materials selected for optimum heat transfer coefficient and structural integrity and containing compressed gas coolant which gas coolant may be selected from any available non-combustible ideal gas for optimum operating pressures, heat transfer coefficients and heat capacities; heat generated by the positron - electron annihilation process in said collision chamber is transferred to said compressed gas contained in said heat transfer chamber; a compressed gas inlet header is connected by piping between said heat transfer chambers and the outlet of a heat exchanger (where the design of said heat exchanger is not included within the subject of this claim) to admit cooled compressed gas from the outlet of said heat exchanger to inlet of said heat transfer chamber; the inlet to said heat exchanger is connected via piping to the compressed gas exhaust of a turbine/rotary engine (where said design of turbine/rotary engine is not included in the subject of this claim); a compressed gas outlet header is attached via piping to the outlet of said heat transfer chamber, and is connected via piping to the inlet of said turbine/rotary engine in order to conduct heated compressed gas from said heat transfer chamber to inlet of said turbine/rotary engine; said piping to the inlet of said turbine/rotary engine includes a three-way control valve to control compressed gas flow to said turbine/rotary engine to meet turbine/rotary engine demand load and to direct excess compressed gas flow to bypass said turbine/rotary engine to compressed gas exhaust from said turbine/rotary engine; the inlets and outlets of said heat transfer chamber are selected at the loci of said heat transfer chamber that result in maximum fluid and heat flow rate in the given configuration through said heat transfer chamber; a baffle plate may be dimensioned and included within the said heat transfer chamber to maximize heat transfer to said compressed gas by increasing the surface area of exposure of said compressed gas to heat produced in said collision chamber; compressed gas exhaust from said turbine/rotary engine is directed through piping connected between said turbine/rotary engine exhaust and the inlet of said heat exchanger to complete a closed thermal circuit; a sub-assembly consisting of said source casings, said positron source emitter, said electron source emitter, said cylindrical solenoid coils, said conical solenoid coils, and said heat transfer cylindrical chamber are mounted within an engine mounting casing dimensioned to fit and secure the body of the engine in a rigid geometrical array; said engine mounting casing includes shielding materials to meet the requirements of the International Atomic Energy Agency Regulations and the regulations of domestic regulators for the nuclear power generation of those countries in which the engine of this claim is applied; said engine mounting may include a staged mounting of more than one said sub-assembly connected through piping connected from said heat transfer chambers of each said sub-assembly to one said compressed gas inlet header and one said compressed gas outlet header, with both said inlet header and outlet headers located exterior to said engine mounting casing; said compressed gas inlet header and said compressed gas outlet header, said turbine/rotary engine, and said heat exchanger are all securely mounted outside said engine mounting casing, with said piping connections between said inlet header said outlet header and said heat transfer chamber made through piping penetrations in the wall of said engine mounting casing; included as an integral part of said piping is a check valve located in said piping between said heat exchanger and said inlet header to prevent reverse flow of compressed gas from said compressed gas inlet header to said heat exchanger.

2. The aperture and said electronic/pneumatic aperture control of Claim 1, specified to open and close said aperture to limit or shutdown admission of electrons and positrons to said solenoid coils for purposes of engine shutdown and maintenance.

3. The compressed gas contained in the combined internal volume of said heat transfer chamber, said outlet header, said piping, said turbine/rotary engine, said heat exchanger, and said inlet header, all of Claim 1, to drive the said turbine/rotary engine through the process of

thermosyphoning and gas expansion per Boyle's Law, wherein the heat input to said compressed gas is provided by the thermal energy of positron - electron annihilation process in said collision chamber, and wherein said heat input is given by the established equation for black-body radiation (i.e., $E \propto kT^4$).

5. The shielded isotope source casing from Claim 1, wherein shielding material and a key interlock is specified and included to allow replacement of said positron source emitter and said electron source emitter to meet radioactive regulatory dose limits obtained in the course of replacement of said source emitters.

6. The positron source emitter and electron source emitter of Claim 1 wherein the respective source emitters are selected to provide the optimum positron and electron emission source terms available for positron-electron annihilation heat generation processes to meet the intended power load of the engine.

7. The pressure of the said compressed gas, per Claim 4, set to optimize heat transfer properties of the gas to support thermosyphoning to meet the intended power load of the said turbine/rotary engine while meeting the ASME Code and domestic code requirements for pressure vessels.

8. A pressure relief system, including pressure relief valves, provided as an intrinsic part of the assembly of the said compressed gas heat transfer chamber, said inlet header, said piping, said turbine/rotary engine, and said heat exchanger, all of Claim 4, to meet the ASME Code and domestic code requirements for pressure vessels.

10. The mounting of the heat exchanger of Claim 1 wherein the mounting is at lower elevation with respect to said engine mounting casing of Claim 1 to support and maximize the thermosyphoning flow of said compressed gas.

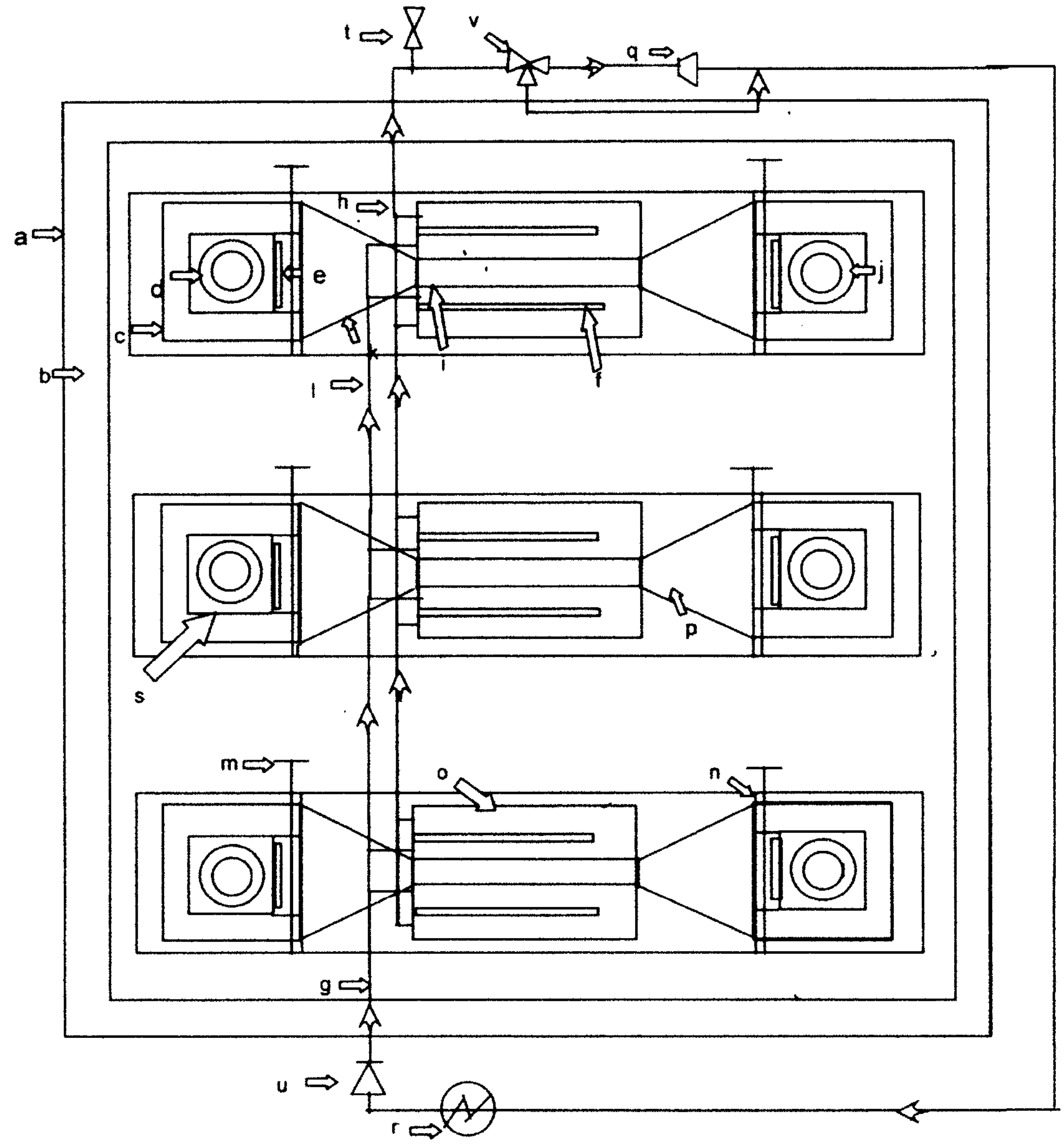
11. The electromagnetic field energy provided by said solenoid coils and said collision chamber, from Claim 1, wherein the electromagnetic field energy is optimized for: the cross-section of positron - electron annihilation where said cross-section is a function of the kinetic energy of the positrons and electrons; the positron - electron flux density within the collision chamber; and the electrical energy input to said solenoid coils and said collision chamber, to produce optimum net power generation of the said apparatus of Claim 1.

12. The baffle plate of Claim 1 dimensioned and installed in cylindrical configuration in said heat transfer chamber of Claim 1 to increase exposure of compressed gas coolant to heat radiation generated in the collision chamber as a function of surface area of compressed gas exposed to heat input relative to the volume of gas in said compressed gas heat transfer chamber, and to optimally reduce the compressed gas chamber length dimensions relative to said collision chamber dimensions.

13. An interlock device provided with the attachment of said emitter source casings and said cylindrical solenoid coils, wherein the interlock device is specified to disconnect said source casing from said conical solenoid coil when the aperture of Claim 2 is closed in order to preserve the engine vacuum.

14. Interlock vacuum seals attached at the interface of said conical solenoid coils and said emitter source casings of Claim 1, specified to ensure vacuum is maintained at operating specification.

FIGURE 1
Positron-Electron Annihilation Fueled Turbine Engine - Staged Mounting Schematic and Flowsheet Diagram



INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2009/001646

A. CLASSIFICATION OF SUBJECT MATTER
IPC: ***G21H 3/00*** (2006.01) , ***G21D 5/08*** (2006.01) , *G21D 3/08* (2006.01) , *H05H 7/06* (2006.01)
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: ***G21H 3/00*** (2006.01) , ***G21D 5/08*** (2006.01) , *G21D 3/08* (2006.01) , *H05H 7/06* (2006.01) in combination with keywords

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
Total Patent, Canadian Patent Database (keywords: antimatter, positron, electron, engine, motor, drive, collision, annihilation, car, automobile)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
L	WO2009021313A1, 19 February 2009 (19-02-2009) see whole document	1-14
A	US2003177756A1, 25 September 2003 (25-09-2003) see whole document	1-14
A	US2004194445A1, 07 October 2004 (07-10-2004) see whole document	1-14
A	US3670494A, 20 June 1972 (20-06-1972) see whole document	1-14

[ ] Further documents are listed in the continuation of Box C.   [X] See patent family annex.

* Special categories of cited documents :
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 August 2010 (18-08-2010)	19 August 2010 (19-08-2010)

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Patent Document Cited in Search Report	Publication Date	Patent Family Member(s)	Publication Date
WO2009021313A1	19 February 2009 (19-02-2009)	WO2009021313A1	19 February 2009 (19-02-2009)
US2003177756A1	25 September 2003 (25-09-2003)	US2003177756A1	25 September 2003 (25-09-2003)
US2004194445A1	07 October 2004 (07-10-2004)	US2004194445A1	07 October 2004 (07-10-2004)
US3670494A	20 June 1972 (20-06-1972)	US3670494A	20 June 1972 (20-06-1972)