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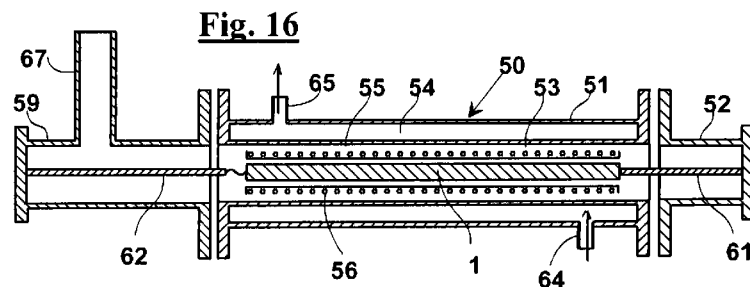
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(54) Title: METHOD FOR PRODUCING ENERGY AND APPARATUS THEREFOR



(57) Abstract: A method and a generator to produce energy from nuclear reactions between hydrogen and a metal, comprising the steps of a) production of a determined quantity of micro/nanometric clusters of a transition metal, b) bringing hydrogen into contact with said clusters and controlling its pressure and speed, preferably after applying vacuum cycles of at least 10^{-9} bar between 35° and 500°C for degassing the clusters; c) creating an active core for the reactions by heating the clusters up to a temperature that is higher than the Debye temperature T_D of the metal, preferably a temperature close to a temperature at which a sliding of reticular planes occurs, in order to adsorb in the clusters the hydrogen as H^{-} ions; d) triggering the reactions by a mechanical, thermal, ultrasonic, electric or magnetic impulse on the active core, causing the atoms of the metal to capture the hydrogen ions, with liberation of heat, preferably in the presence of a gradient of temperature on the active core; e) removing the heat maintaining the temperature above T_D , preferably in the presence of a magnetic and/or electric field of predetermined intensity. The active core can comprise a sintered material of micro/nanometric clusters, or a clusters powder collected in a container, or a deposit of clusters onto a substrate of predetermined volume and shape, with at least 10^9 clusters per square centimetre of surface, obtainable by means of methods such as sputtering, spraying evaporation and condensation of metal, epitaxial deposition, by heating up to approaching the melting point and then slow cooling, such methods followed by quick cooling for freezing the cluster structure.



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TITLE

METHOD FOR PRODUCING ENERGY AND APPARATUS THEREFOR

DESCRIPTIONField of the invention

5 The present invention relates to a process for producing energy by nuclear reactions between a metal and hydrogen that is adsorbed on the crystalline structure of the metal. Furthermore, the invention relates to an energy generator that carries out such reactions.

Description of the prior art

10 A method for producing heat by nuclear reactions caused by hydrogen that is adsorbed on a Nickel active core has been described in WO95/20316, in the name of Piantelli et. al.. Improvements of the process are described in Focardi, Gabbani, Montalbano, Piantelli, Veronesi, "Large excess heat production in Ni-H systems", in Il Nuovo Cimento, vol. IIIA, N.11, november 1998, and bibliography
15 therein.

A problem that was observed during the experiments was the preparation of the cores on which hydrogen had to be adsorbed and the reactions had to be carried out; such cores were made of Nickel and had the shape of small bars.

20 One of the various critical aspects of the process was the choice of a suitable method for adsorbing hydrogen and the quality of the hydrogen matter, as well as the repeatability of the triggering conditions of the process.

Other critical aspects were how to clean the small bar before the adsorption of the hydrogen, as well as how to optimize the optimal bar surface conditions and the method for triggering and shutting down the reactions.

25 Due to such problems, the set up of the process and its industrial exploitation turned out to be somewhat difficult.

A further critical aspect is the core sizing and design to attain a desired power.

30 In DE4024515 a process is described for obtaining energy from the nuclear fusion of hydrogen isotopes, in which the atoms are brought into contact with clusters that contains from three to one hundred thousand atoms of a

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transition metal, and in which the clusters are obtained by cooling finely subdivided metal particles.

Summary of the invention

5 It is therefore a feature of the present invention to provide a method for producing energy by nuclear reactions of hydrogen that is adsorbed in a crystalline structure of a metal, which ensures repeatability of the triggering conditions of the reactions.

10 It is, furthermore, a feature of the present invention to provide such a method for industrially making the precursors of the active cores, and for industrially adsorbing hydrogen in them.

It is another feature of the present invention to provide an energy generator that effects the above described nuclear reactions, whose production rate and size are also such that an industrial production is allowed.

15 It is similarly a feature of the present invention to provide such a generator, which allows easily adjusting the output power.

It is a further feature of the present invention to provide such a generator, which can be easily shut down.

20 These and other features are accomplished by a method for producing energy by nuclear reactions between hydrogen and a metal, said method providing the steps of:

- prearranging a determined quantity of crystals of a transition metal, said crystals arranged as micro/nanometric clusters that have a predetermined crystalline structure, each of said clusters having a number of atoms of said transition metal which is less than a predetermined number of atoms;
- 25 – bringing hydrogen into contact with said clusters;
- heating said determined quantity of clusters up to an adsorption temperature larger than a predetermined critical temperature, that is adapted to cause an adsorption into said clusters of said hydrogen as H⁻ ions, said hydrogen as H⁻ ions remaining available for said nuclear reactions within said
- 30 active core after said heating step;
- triggering said nuclear reactions between said hydrogen as H⁻ ions and said metal within said clusters by an impulsive action exerted on said active core

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that causes said H- ions to be captured into respective atoms of said clusters, said succession of reactions causing a production of heat;

– removing said heat from said active core maintaining the temperature of said active core above said critical temperature, said step of removing said heat
5 carried out according to a predetermined power.

Advantageously, said step of prearranging is carried out in such a way that said determined quantity of crystals of said transition metal in the form of micro/nanometric clusters is proportional to said power.

The number of atoms that form each cluster is the variable through which
10 the predetermined power can be obtained from an active core that comprises a predetermined amount of metal. In fact, each cluster is a site where a reaction takes place, therefore the power that can be obtained is substantially independent from the clusters size, i.e. from the number of atoms that form the cluster.

15 In particular, the number of atoms of the clusters is selected from a group of numbers that are known for giving rise to structures that are more stable than other aggregates that comprise a different number of atoms. Such stability is a condition to attain a high reactivity of the clusters with respect to hydrogen to give H- ions. For instance, a stability function has been identified for Nickel,
20 which depends upon the number of atoms that form the clusters, obtaining specific stability peaks that correspond to that particular numbers.

The hydrogen that is used in the method can be natural hydrogen, i.e., in particular, hydrogen that contains deuterium with an isotopic abundance substantially equal to 0,015%. Alternatively, such hydrogen can be hydrogen
25 with a deuterium content which is distinct from that above indicated, and/or hydrogen with a significant tritium content.

Preferably, the hydrogen in use is molecular hydrogen H₂; alternatively, the hydrogen is preliminarily ionized as H⁻, or it can be a mixture that contains H⁻ and H₂.

30 The transition metal can be selected from the group comprised of: Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Zn, Y, Zr, Nb, Pd, Mo, Tc, Ru, Rh, Ag, Cd, Lu, Hf, Ta, W, Re, Os, Ir, Pt, Au, lanthanoids, actinoids. Such metals belong to one of the four transition groups , i.e.:

– metals that have a partially filled 3d-shell, e.g. Nickel;

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- metals that have a partially filled 4d-shell, e.g. Rhodium;
- metals that have a partially filled 5d-shell, i.e. the "rare earths" or lanthanoids, e.g. Cerium;
- metals that have a partially filled 5d-shell, i.e. the actinonoids, e.g. Thorium.

The metal in use can also be an alloy of two or more than two of the above listed metals.

Among the listed transition metals, or their alloys, the ones are preferred those that crystallize with a crystalline structure selected from the group comprised of:

- face-centred cubic crystalline structure;
- body-centred cubic crystalline structure;
- compact hexagonal structure.

Advantageously, metals are used that have a crystalline open face structure, in order to assist the H- ions adsorption into the clusters.

Preferably, said transition metal is Nickel. In particular, said Nickel is selected from the group comprised of:

- natural Nickel, i.e. a mixture of isotopes like Nickel 58, Nickel 60, Nickel 61, Nickel 62, Nickel 64;

- a Nickel that contains only one isotope, said isotope selected from the group comprised of:

- Nickel 58;
- Nickel 60
- Nickel 61;
- Nickel 62;
- Nickel 64;

- a formulation comprising at least two of such isotopes at a desired proportion.

The H- ions can be obtained by treating, under particular operative conditions, hydrogen H₂ molecules that have been previously adsorbed on said transition metal surface, where the semi-free valence electrons form a plasma. In particular, a heating is needed to cause lattice vibrations, i.e. phonons, whose energy is higher than a first activation energy threshold, through non-linear and anharmonic phenomena. In such conditions, the following events can occur:

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– a dissociation of the hydrogen molecules that is adsorbed on the surface;
– an interaction with valence electrons of the metal, and formation of H⁻ ions;
– an adsorption of the H⁻ ions into the clusters, in particular the clusters that form the two or three crystal layers that are most close to the surface. The H⁻ ions can just physically interact with the metal, or can chemically bond with it, in which case hydrides can be formed.

The H⁻ ions can also be adsorbed into the lattice interstices, but

– adsorption at the grain edges, by trapping the ions into the lattice defects;
– replacement of an atom of the metal of a clusters

may also occur.

After such adsorption step, the H⁻ ions interact with the atoms of the clusters, provided that a second activation threshold is exceeded, which is higher than the first threshold. By exceeding this second threshold, in accordance with the Pauli exclusion principle and with the Heisenberg uncertainty principle, the conditions are created for replacing electrons of metal atoms with H⁻ ions, and, accordingly, for forming metal-hydrogen complex atoms. This event can take place due to the fermion nature of H⁻ ion; however, since H⁻ ions have a mass 1838 times larger than an electron mass, they tend towards deeper layers, and cause an emission of Auger electrons and of X rays. Subsequently, since the H⁻ ion Bohr radius is comparable with the metal core radius, the H⁻ ions can be captured by the metal core, causing a structural reorganization and freeing energy by mass defect; the H⁻ ions can now be expelled as protons, and can generate nuclear reactions with the neighbouring cores.

More in detail, the complex atom that has formed by the metal atom capturing the H⁻ ion, in the full respect of the energy conservation principle, of the Pauli exclusion principle, and of the Heisenberg uncertainty principle, is forced towards an excited status, therefore it reorganizes itself by the migration of the H⁻ ion towards deeper orbitals or levels, i.e. towards a minimum energy state, thus emitting Auger electrons and X rays during the level changes. The H⁻ ion falls into a potential hole and concentrates the energy which was previously distributed upon a volume whose radius is about 10^{-12} m into a smaller volume whose radius is about 5×10^{-15} m. At the end of the process, the H⁻ ion is at a distance from the core that is comparable with the nuclear radius; in fact in the

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fundamental status of the complex atom that is formed by adding the H⁻ ion, due to its mass that is far greater the mass of the electron, the H⁻ ion is forced to stay at such deep level at a distance from the core that is comparable with the nuclear radius, in accordance with Bohr radius calculation. As above stated, owing to the short distance from the core, a process is triggered in which the H⁻ ion is captured by the core, with a structural reorganization and energy release by mass defect, similarly to what happens in the case of electron capture with structural reorganization and energy release by mass defect or in case of loss of two electrons, due to their intrinsic instability, during the fall process towards the lowest layers, and eventually an expulsion of the the H⁻ ion takes place as a proton, as experimentally detected in the cloud chamber, and nuclear reactions can occur with other neighbouring cores, said reactions detected as transmutations on the active core after the production of energy.

According to the above, the actual process cannot be considered as a fusion process of hydrogen atoms, in particular of particular hydrogen isotopes atoms; instead, the process has to be understood as an interaction of a transition metal and hydrogen in general, in its particular form of H⁻ ion.

Advantageously, said predetermined number of said transition metal atoms of said clusters is such that a portion of material of said transition metal in the form of clusters or without clusters shows a transition of a physical property of said metal, said property selected from the group comprised of:

- thermal conductivity;
- electric conductivity;
- refraction index.

The micro/nanometric clusters structure is a requirement for producing H⁻ ions and for the above cited orbital and nuclear capture processes. For each transition metal, a critical number of atoms can be identified below which a level discrete structure (electronic density, functional of the electronic density and Kohn-Sham effective potential) and Pauli antisymmetry, tend to prevail over a band structure according to Thomas-Fermi approach. The discrete levels structure is at the origin of the main properties of the clusters, some of which have been cited above. Such features can be advantageously used for aqnalysing the nature of the surface, i.e. for establishing whether clusters are present or not.

