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(54) **ELECTRICITY GENERATION SYSTEM BASED ON NITROGEN**

AUF STICKSTOFF BASIERENDES ELEKTRIZITÄT SERZEUGUNGSSYSTEM

SYSTEME DE PRODUCTION D'ELECTRICITE UTILISANT DE L'AZOTE

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Description

FIELD OF THE INVENTION

[0001] The innovation herein proposed describes an electricity generation system based on Nitrogen and its use.

PREVIOUS TECHNIQUES

[0002] The increasing concern about environmental issues, especially relative CO₂ emission reduction associated to the expansion of the Brazilian electricity sector starts to stimulate the development and the use of alternative forms of electric energy generation in Brazil.

[0003] In particular the clean and renewable generation systems are being seen as priority, nowadays. The market of wind sources, solar energy and small hydro-electric power plants is increasing fastly.

[0004] Therefore, in this context, new clean and renewable technologies for energy generation started to be investigated in order to substitute the traditional sources.

[0005] The electrical energy generation from hydrogen is one of the alternatives that is under research.

[0006] Another important trend that is gaining strong support in the current scenario is the distributed generation, that is the power generation from small units (small scale generation) close to the consumer. The distributed energy becomes even more important due to the following factors:

- The necessity to supply consumers isolated from the electrical system. In rural areas, the development of local independent systems can eliminate the for increasing the distribution grid;
- The occurrence of several black-out of great extension that has been verified in many countries, causing great damages and inconveniences to the consumers. The generated energy locally demands less of the transmission electrical systems, and provides high reliability and low vulnerability for the centered electrical systems that occur, for example, due to serious climatic conditions;
- The increasing demand for 'green energy'. The related commitments to the climatic changes and efforts by environment conservation;
- Other factors - Reduced dependence in oil importation, lower atmospheric pollution, risks reduction of nuclear security, difficulties of localization of new power plants and the transmission and distribution capacity, technological advances, new exportation markets.

[0007] The development of new technologies that can guarantee this increasing market of distributed energy is more relevant and with priority.

[0008] In a limit case, the ideal would be that each res-

idence could have its local (private) generation, that is, small generators of electric energy.

[0009] These small domestic generators can best represent a change in the philosophy of the 'the bigger, the better' of the electricity generation that has prevailed in the energy sector - with the construction of huge hydro electrical plants, the coal and nuclear that, nowadays, supply great part of the world-wide electricity.

[0010] In summary, several technological, environmental and political forces stimulate the use of the decentralized energy concept, in small scale, clean and renewable.

[0011] This patent presents an alternative form of clean, renewable and distributed electric energy generation, based on Nitrogen.

[0012] The Nitrogen is the main element in air (about 78%), therefore a renewable source of electric energy generation. Moreover, the equipment herein described represents a clean and distributed form of electricity generation.

[0013] The Nitrogen can be stored in liquid form facilitating the transport and positioning, where the energy is necessary and, therefore its use as fuel for distributed, clean and renewable generation of electric energy.

[0014] The order of patent in Brazil PI 0202191-9 (date 03/06/2002) describes a generator using the Nitrogen where the potential difference is generated from the super conduction of the magnetic forces generated by a big magnet.

[0015] Closest prior art US2964917 discloses a regasification process for liquefied gas like methane, oxygen or nitrogen, to obtain the gas at a specific pressure and during which electrical energy is obtained as side effect.

SUMMARY OF THE INVENTION

[0016] The considered system is an electricity generator that uses the ambient temperature to heat up and vaporize liquid Nitrogen, which is stored at low temperature, and is pumped at high pressure through a heat exchanger. The high pressure vaporized Nitrogen gas is expanded in an expander, which generates mechanical power that drives an electricity generator.

DETAILED DESCRIPTION OF THE INVENTION

[0017] The present invention is composed by an electric energy generation system using liquid Nitrogen, as shown in figure 1, where V represents the storage vessel of liquid Nitrogen, B is a pump, TC is the heat exchanger, D a control device, EXP expander and CEE electric energy converter. There is, also, a set of valves (not shown in figure) that controls the Nitrogen flow in the system. The valves are also used for the protection and the restart of the system.

[0018] The diagram from figure 1 illustrates the basic principle of operation.

[0019] The Liquid Nitrogen, initially stored in a pressure

vessel, V, is pumped to the operating pressure of the system in the pump B, after which it is directed into the heat exchanger, TC. The heat exchanger works in a similar form to a car radiator, however, instead of using air to cool, it uses air to heat the Nitrogen.

[0020] The liquid Nitrogen passes through pipes that compose the heat exchanger, where it is heated and vaporized by a stream of air at ambient temperature. After that it is expanded in an expander, EXP, generating mechanical power, which is converted into electricity by an electrical generator (CEE). The Nitrogen is set free to the atmosphere.

[0021] The Nitrogen flow to the expander inlet is controlled by a device, D.

[0022] The considered system is modular and several of them can be connected to increase the capacity of electric energy generation (power and energy), through the combination of Nitrogen storage vessels in parallel to the heat exchanger or by the combination of some Nitrogen storage vessels and heat exchanger in parallel to the expander as shown in figure 2, and others.

[0023] It is possible to add other components into the system in order to increase its efficiency. For example:

■ The adoption of fans to blow the air with higher efficiency, i.e., the surrounding heat at the heat exchanger.

■ The physical and geometric constitution of the heat exchanger could be enhanced aiming a better efficiency. It can be optimized using other pipe configurations by better exposition of the heat exchanger surface to the surrounding air and light, aiming at improving the surrounding heat transference to the liquid Nitrogen.

■ The Nitrogen gas at the exit of the expander can be re-used for pre-heating of the liquid Nitrogen in the heat exchanger.

■ The Nitrogen gas from the expander can still be used as working fluid in a second stage of heat transfer and expander generating more mechanical work. The number of stages used depend on the desired efficiency and required power by the system.

[0024] The system has a low cost to generate a clean, renewable and distributed energy:

■ For supplying consumers located in isolated regions of the electrical system (off grid consumers).

■ For supplying a consumer or group of consumers located in regions of high commercial losses and high insolvency.

■ That allows the selling of energy, before its use, implementing the concept of pre paid energy in a consumer or a group of consumers located in high commercial losses regions and high insolvency.

■ To use in residences, in specific applications such as efficient illumination and water heating, amongst others.

■ To replace local diesel generators reducing the emissions.

5 Claims

1. Electricity generation system, based on liquefied nitrogen, comprising a storage vessel (V) of liquefied nitrogen, a pump (B), a heat exchanger (TC), an expander (EXP) and an electric energy converter (CEE), **characterized by** arranging a control device (D) between said heat exchanger (TC), and said expander (EXP) to control the inlet of nitrogen to said expander (EXP), providing an off-grid electricity generation system.
2. Electricity generation system according to claim 1, **characterized by** modularity, wherein a plurality of storage vessels (V_1 - V_4) are arranged in parallel, providing a varied electric energy generation capacity in accordance with the load necessity.
3. Electricity generation system according to claim 2, **characterized by** having also a plurality of heat exchangers (TC_1 - TC_4).
4. Electricity generation system according to claim 1, 2 or 3, **characterized by** means arranged to re-use the nitrogen at the exit of the expander (EXP) for pre-heating of the liquid nitrogen.

Patentansprüche

1. Elektrizitätserzeugungssystem, basierend auf verflüssigtem Stickstoff, umfassend ein Speichergefäß (V) zum Speichern von verflüssigtem Stickstoff, eine Pumpe (B), einen Wärmetauscher (TC), eine Gasexpansionsturbine (EXP), und einen Wandler für elektrische Energie (CEE), **gekennzeichnet durch** Anordnen einer Steuervorrichtung (D) zwischen dem Wärmetauscher (TC) und der Gasexpansionsturbine (EXP), um den Einlass von Stickstoff in die Gasexpansionsturbine (EXP) zu steuern, wodurch ein Elektrizitätserzeugungssystem außerhalb des Netzes bereitgestellt wird.
2. Elektrizitätserzeugungssystem nach Anspruch 1, **gekennzeichnet durch** Modularität, wobei mehrere Speichergefäße (V_1 - V_4) parallel angeordnet sind, um verschiedene Elektrizitätserzeugungskapazitäten gemäß der benötigten Last bereitzustellen.
3. Elektrizitätserzeugungssystem nach Anspruch 2, **dadurch gekennzeichnet, dass** es ebenfalls mehrere Wärmetauscher (TC_1 - TC_4) aufweist.

4. Elektrizitätserzeugungssystem nach Anspruch 1, 2 oder 3, **gekennzeichnet durch** Mittel, die angeordnet sind, den Stickstoff am Ausgang der Gasexpansionsturbine (EXP) wiederzuverwenden, um den verflüssigten Stickstoff vorzuwärmen.

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Revendications

1. Système de production d'électricité, utilisant de l'azote liquéfiée, comprenant un récipient de stockage (V) d'azote liquéfiée, une pompe (B), un échangeur de chaleur (TC), une unité de détente (EXP) et un convertisseur d'énergie électrique (CEE), **caractérisé par** l'agencement d'un dispositif de commande (D) entre ledit échangeur de chaleur (TC) et ladite unité de détente (EXP) pour commander l'entrée de l'azote dans ladite unité de détente (EXP), fournissant un réseau autonome de production d'électricité.
2. Système de production d'électricité selon la revendication 1, **caractérisé par** une modularité, selon laquelle une pluralité de récipients de stockage (V_1 - V_4) est disposée en parallèle, permettant une capacité variée de production d'énergie électrique en fonction des besoins de charge.
3. Système de production d'électricité selon la revendication 2, **caractérisé en ce qu'il** a également une pluralité d'échangeurs de chaleur (TC_1 - TC_4).
4. Système de production d'électricité selon la revendication 1, 2 ou 3, **caractérisé par** un moyen agencé pour réutiliser l'azote à la sortie de l'unité de détente (EXP) pour le pré-chauffage de l'azote liquide.

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FIGURES

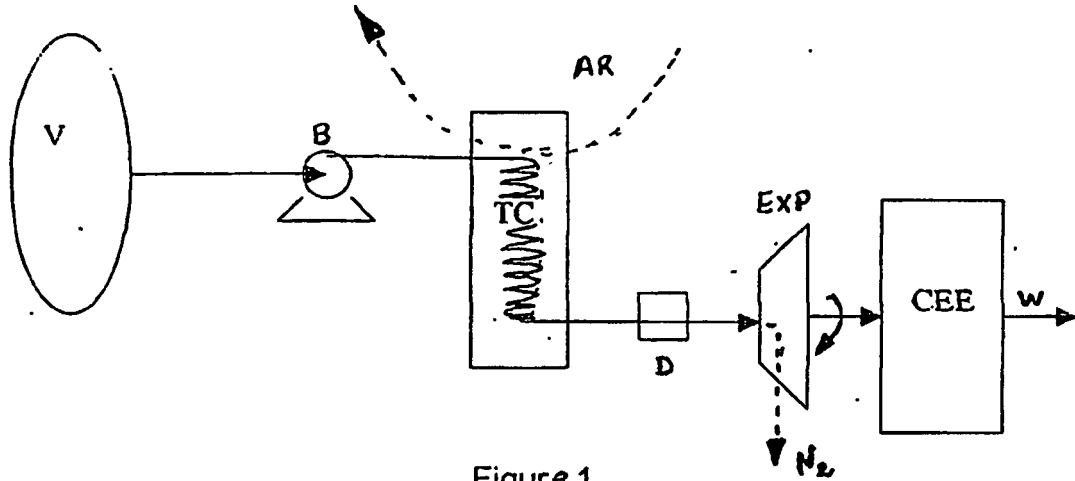


Figure 1

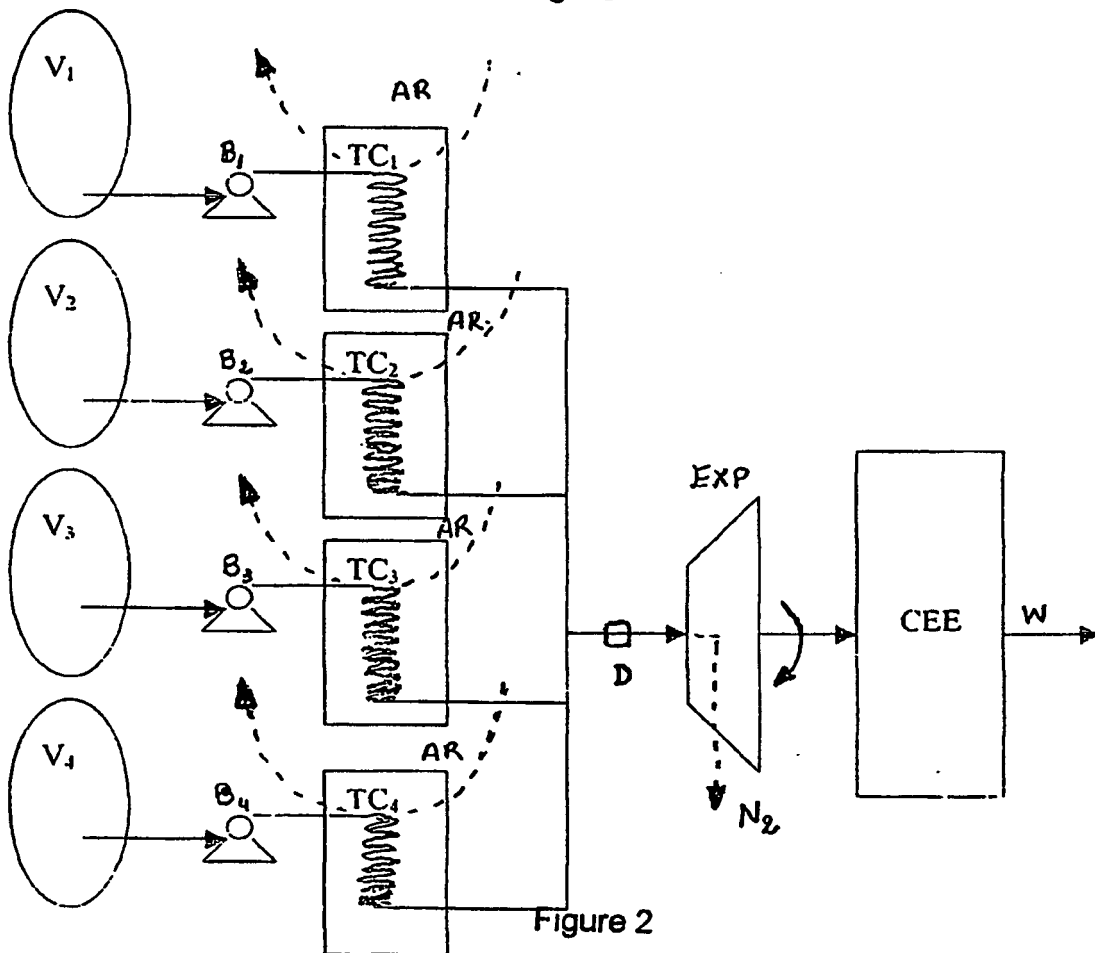


Figure 2

REFERENCES CITED IN THE DESCRIPTION

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