GYROSCOPIC SOLAR POWER SATELLITE ENERGY SYSTEMS WITH ELEMENTAL COMPATIBILITY OF COMPONENTS AND A NEW ALGORITHM FOR CONVERTING SOLAR RADIATION ENERGY

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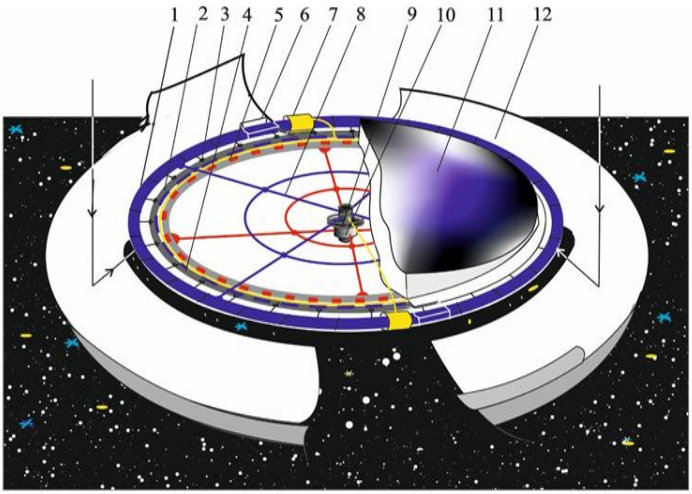
The chemical and petrochemical sector is of vital economic importance. Global production amounted to 5.7 trillion United States dollars (USD) in 2017, including pharmaceuticals. Production is projected to quadruple by 2060 [1]. The sector's reliance on fossil fuels and fossil feedstocks results in the emissions of carbon dioxide (CO2) during the production, use and end-of-life phases. As a result, the chemical and petrochemical sector is a major contributor to global industrial CO2 emissions, ranking third behind iron and steel-making and cement production. Total direct emissions from production, product use and waste handling amounted to 1.6 gigatonnes (Gt) of CO2 per year, while indirect emissions related to electricity supply accounted for 0.6 Gt of CO2 per year. Production of chemicals results in around 1.1 Gt of energy and processing CO2 emissions annually, accounting for about half of the full life cycle carbon footprint (estimated based on Ref. [2]).

Solar process heating systems can replace fossil fuels for process heat generation [3,4].

Design developments of an effective original method for converting solar radiation by gyroscopic solar power satellite with a new thermal conversion algorithm, rather than previously developed, will not leave designers and developers without attention to the concept of poor development of space energy. Their implementation will lead to partial replacement of irreplaceable natural Earth energy resources. The peculiarity of the proposed projects reveals the fact of the discovery of the combination of multifunctional processes with the same components of the design of gyroscopic solar power satellite (GSPS) in converting the energy of the full spectrum of solar radiation into mechanical and electrical in the necessary ratios and is justified by the following provisions.

This is the leading idea of projects, as a combination of processes, belongs to the algorithm for the continuous conversion of solar energy by performing useful work by the working fluid in the sunflower region and in shading, even when the heat is released into space. It is substantiated by the architecture of the GSPS structure, which looks like a single technical structure made of a circular parabolic solar concentrator with heat-converting modules. They are placed in a heat trap of the focal region of concentrated radiation along the perimeter of one of the two concentric bearing trusses. On the farms in the center or at the periphery of the shadow area, depending on the version of the GSPS design, the components of the superconducting electric generator are located. The trusses have the possibility of opposite rotation around the axis oriented to the sun through interaction through the kinematic coupling nodes from the modules (Fig.1).



a

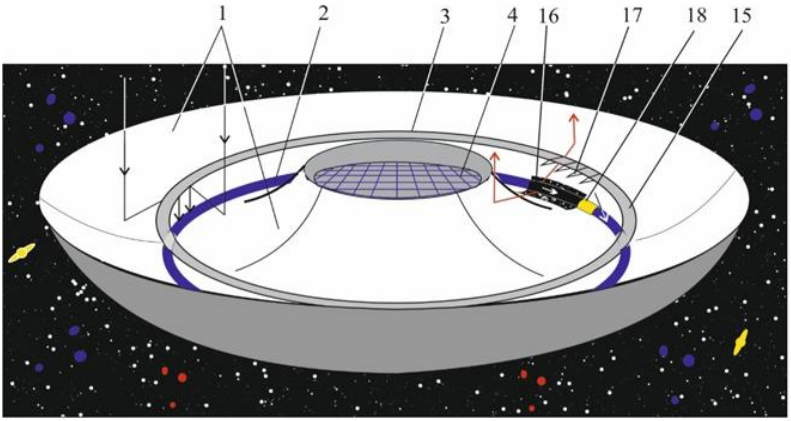
Fig.1. The schemes of the GSPS with concentrators.

A feature of the created project of a gyroscopic space solar power station (GSPS) with a new thermal conversion system (TCS) and a superconducting generator is a fundamentally different approach for converting the energy of the full spectrum of solar radiation into mechanical and electrical in the necessary ratios than were previously developed in the field of space energy [5].

The argumentation of the key feature of a heat trap, in the traditional terminology of a radiation heat receiver, is its constructive solution of a circular tunnel cavity made of a transparent film with low-emission magnetron sputtering. An enlarged concentrator in front of the entrance of thermal modules from the heat-emitting (cold) region to the heat trap compensates for the losses due to reflection of that incident part of the infrared radiation spectrum on the film that did not pass through it. This makes it possible to make a correction for the calculated value of the energy supplied to the heat trap at the stage of rapid heating of the working fluid in the heat-converting modules. Radiation transmitted with a small wavelength is "transformed" into radiation energy from heated modules with a working fluid into radiation with a longer wavelength, which do not pass outside, but are used to perform useful work on rotating farms with a component of a superconducting generator on them, which is always in the shadow low temperature areas.

In another version of the GSPS design, the heat trap has a rigid torus shape made of heat-resistant durable heat-insulating material with a mirror-like inner surface. In this case, the leading idea of the elemental compatibility of multifunctional transformation processes remains the same, so in the variants of the basic structures of the GSPS in the sunflower region along the surface of the heat trap, the width of the focal spot, concentrated radiation passes the opening into the heat trap. This ensures that the modules with the working fluid absorb the energy of the full spectrum of solar radiation that has passed through the opening. The rods from the modules pass through the side cut as rotation drives of the bearing trusses. The stage of transferring all the stored

thermal energy by the module and the working fluid in it, if necessary, to work in the absence of a concentrator and an opening in a heat trap does not contradict the laws of thermodynamics. Thus, heat-converting modules moving in the circular cavities of heat traps and outside acquire the purpose of a heat receiver, a refrigerator-emitter, a gyroscopic guidance system with rotating trusses in the sun, drives for rotating the shafts of electric generators and a slight gravity necessary for the crew and technological processes (Fig.2).



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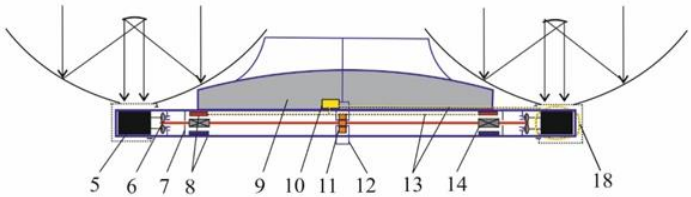

b

Fig.2.The GSPS and the compound film concentrator of solar radiation above the heat receiver (a), the power plant cross-sectional view (b).

The design solution of the GSPS in the solar energy conversion algorithm eliminates the most important problem of resonating mechanical effects in zero gravity from moving units due to the smoothly varying loading action of the rods from the modules on the rotation of the bearing trusses. The angular speed of rotation of the trusses relative to a fixed frame of reference (the Sun) with a fixed area of the concentrator, in turn, varies by the moment of inertia (the placement of production equipment on the trusses in radial directions).

It will be more convenient to solve the tasks of putting the GSPS into orbit by testing with a preliminary study of the model installation in a pressure chamber. The GSPS under test is assembled in terrestrial conditions with the central part of a superconducting electric generator (or with neodymium magnets) placed in a launch vehicle. The rest of the components, as in the project, are placed on the trusses outside on the perimeter of the carrier rocket body with a fairing over the heat trap to reduce atmospheric resistance. In another version of the tested GSPS, the heat trap is made of a durable material with low thermal conductivity and located above it, under the fairing of a folded concentrator with the possibility of automated deployment in orbit. In the conceptual plan, in addition to the main purpose of the GSPS, as an option, it is envisaged the production of ultrapure materials for the accumulation of charge with subsequent sending to the Earth to create energy storage systems. For more details see here: https://maryinskykh.ishostka.sumdu.edu.ua.

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