ELECTRO-MAGNETIC PROPULSION SYSTEM (EMPS) FOR SPACECRAFTS AND SATELLITES

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Summary: The subject of the proposal is an electro-magnetic propulsion system for new generation driving satellites and other spacecraft, which has smaller mass, smaller volume and more efficiency compared with the known, state of the art ion propulsion systems applied in space technology.

Background of the problem to be solved: The backdraw of the state of the art and traditionally applied jet base propulsion systems is, that the driving material for their operation must be carried along, and after a whilethey run out, their operation is complicated. A new generation of propulsion systems for driving satellites and other spacecraft have been lately developed. Such as eg. Magnetohidrodinamic (MHD), Pulsed Electromagentic Plasma, Electrostatic Ion, Magnetoplasmadynamic, Pulsed Inductive, Electrodeless Plasma, Hall Effect propulsion systems.

General conditions: In connection with the functioning of the propulsion system it must be taken into consideration, that the space between the planets and the space between the stars is not homogenous, but there are various particle condensations, rarefaction in them. Around celestial bodies, planets, in given case moons, particle density is bigger, respectively heterogenous, resulting partly from gravity and partly from emission, partly from material discharge. In case of the Sun the material flow is substantial, it can be observed even in the outer parts of the Sun system.

The interaction with the magnetic and/or electric space is an important physical parameter from the point of view of the operation of the propulsion system. On the surface of the Earth the magnetic field strength is 25,000-65,000 nT depending on the spot. The magnetic field strength generated by the Sun in the outer space in the distance of the Earth is 6 nT. The magnetic field strength is considerably bigger near the Sun, as well as in the surroundings of the huge planets.

The theory of our solution: The propulsion system according to the proposal works with a reversible electrodynamic change of state, that can be changed in an electrodynamic way, and it transforms the output carried by the voltage and current into kinetic energy.In case of a mechanical finish, a coil of close wound conductors is used. The coil consists of an external coilpart, placed along the external covering of the propulsion system frame,a rotor of spherical shape, preferably of discus shape, as well as an internal, cylindrically shaped coil-part placed in the interior of the propulsion frame on a common shaft with the propulsion frame of body of rotation.The coil is connected electronically with the controller directing the current of the coil.

Our proposal: Electro-Magnetic Propulsion System (EMPS) where several close wound conductors are placed next to each other on the mantle of the rotor, as well as inside the surface of the cylinder. Resulting from this E electric magnetic field and shaft-symmetrical H magnetic field are created on the mantle of the rotor, which are perpendicular to each other. The direction of the propagation of electromagnetic energy is shown by S Poynting vector. The direct result of the operation is, that eg. such tangential force pairs come to existence in the rotational plane of the device, which impose mechanical impact, torque on the space surrounding the device.

The Fig 1,2 show the momentary flux and spatial arrangement of the electromagnetic field forming under the influence of the energizing in different given cases.

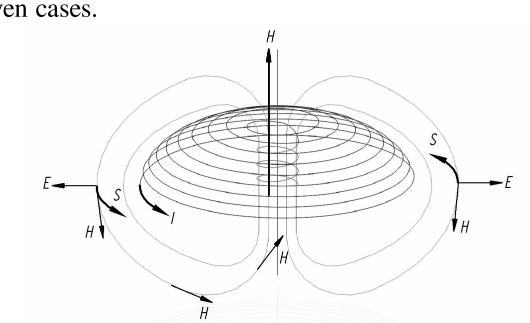

Fig. 1 shows the momentary arrangement of the electromagnetic field created by the propulsion system by the applicatoin of straight cable with I current

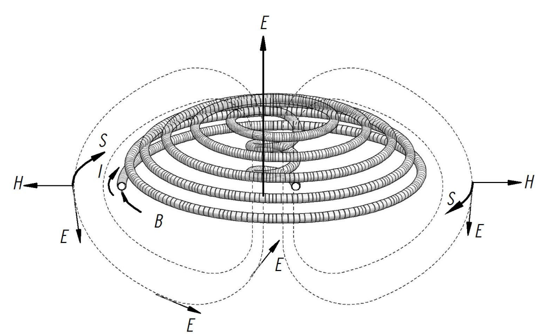

Fig. 2 shows the momentary arrangement of the electromagnetic field created by the propulsion system by the applicatoin of solenoid cable with I current

The operation of the propulsion unit: The electromagnetic field (Poynting vector, S) emitted by the propulsion system unit transfers an impulse of identical direction with the propagation of the wave to the field surrounding the propulsion system. The electromagnetic impulse emitted this way imposes an impact to the field surrounding the propulsion system, as well as to the elemental particles in it, resulting in a relative shift (law of conservation of impulse) between the propulsion system and the given part of the space.

That is, the elemental particles surrounding the propulsion system shift to one direction, whereas the propulsion system unit, respectively together with it the spacecraft connected to it, shifts to the opposite direction on basis of law of action-reaction.

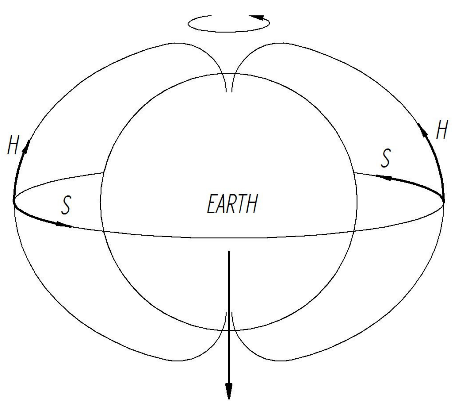

Fig. 3 shows the application of EMPS propulsion system in case of a satellite orbiting the Earth during interaction with the magnetic field H of the Earth.

Feasibility study: The external coil-parts are arranged along a rotor, eg. sphere, or ellipsoid of rotation, spherical body. In the rotational shaft, in an identical shaft a cylindrical hollow is formed, the internal coil-part is shaped along the internal mantle of said cylindrical hollow. The coil can have one, or several turns. Different electronic controls are connected to it. The geometrical dimensions of the device are: from a few centimeters up to several meters. The output can be planned according to demand.

Functional methods: During operation an impulse-like control is used, and resulting from this control, the propulsion unit forms around itself an impulse-like, special electric and magnetic field described earlier, which changes with time.

As an additional application it is also possible, that the energy necessary for the functioning of the electric units of the propulsion system is ensured by using, collecting energy from external space. Solar elements, solar cells can be used for this purpose. Such a way the propulsion system unit according to the invention offers the possibility of creating and driving a spacecraft for long distance and long term use.

The possibilities of the realizations: Several trials have been carried out and the mechanical power effect that can be created with the help of S Poynting-vector was tested with different geometrical (cylinder shaped, spherical and rotational ellipsoide shape) arrangements. In impulse function a surprisingly big power effect could be created. According to experiences the degree of the mechanical power effect that can be created with the electromagnetic field changing in time, changes in proportion with the second power of electric E, or magnetic H field strength.

Practical findings: In the frame of a research-development project two pieces of EMPS prototypes of nominal output of 2.5 kW each were built. Findings measured under Earth surface conditions (Budapest, Hungary) show, that 1 N thrust can be produced with 2.5 kW nominal output even without driving material.

Preferable applications: Further improvement and marketing of EMPS technology can bring about significant competition advantage in every field of application where considerable unit output from small mass and high efficiency is a basic requirement. Such fields of application are space technology and aircraft production.

Advantages: EMPS propulsion system is able to perform much bigger range thrust compared with known ion and plasma propulsion drivers. The increase of thrust in such extent goes together with the increase of travelling speed, resulting in bigger range in the outer space of negligible small resistance of medium. The arrangement does not include moving parts, and it is a little sensitive to the changes of external conditions primarily to the changes of external temperature. Resulting from beneficial efficiency, a driver of smaller mass and smaller volume can be made, which is especially advantageous in case of flight deck systems.

References: [1] Peter Y. Peterson, et Alec D. Gallimore „The Performance and Plume Characterization of a Laboratory Gridless Ion Thruster with Closed Electron Drift Acceleration" American Institute of Aeronautics and Astronautics (AIAA)-2004-3936, [2] Eric J. Pencil et al. "Overview of Advanced Electromagnetic Propulsion Development at NASA Glenn Research Center" American Institute of Aeronautics and Astronautics (AIAA)-2005-4227, [3] Martin Tajmar „Advanced Space Propulsion Systems" Lecture 317.014, Institute for Lightweight Structures and Aerospace Engineering Space Propulsion, ARC Seibersdorf research