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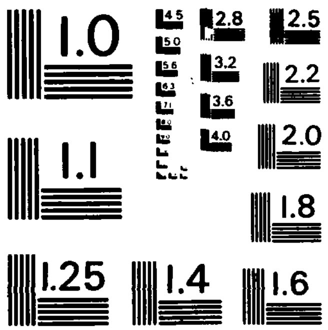

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POWER PLANTS IN SPACE

by

Wadim Wiktorow

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POWER PLANTS IN SPACE

by Eng. Wadim Wiktorow

In astronautical equipment, electrical energy serves to power automatic control systems, radio communications and scientific apparatuses.

The basic means for obtaining this energy is by transforming solar energy into electricity. Silicon solar batteries were first used in the "Sputnik 3" in 1958. Since then, sheets of solar batteries have been seen on the Kosmos, Meteor and Molnia type satellites, on the Venus and Mars interplanetary probes, on the Sojuz manned spaceships and on the Salut orbital space station. Also, the Soviet moon vehicle, the Lunochod, used electrical energy to propel itself.

The principle of the activity of these batteries rests in the direct transformation of solar light photons into electricity. The requirements for photovoltaic converters, which operate in space, are very rigorous. On one hand, they should absorb the greatest solar energy, and on the other hand, the possibility of their overheating must be avoided, since the output of the photovoltaic converters decreases as the temperature rises. Besides this, they ought to resist the harmful effects of cosmic radiation and micrometeors over a long period of time. This, naturally, requires increasing the solar battery's mass, which is a drawback any way you look at it.

Chemists have proposed, consequently, a new type of protection--a thin transparent layer of glass (0.2 to 1.5 mm). Achievements in semi-conductor production technology and theoretical progress in physics have allowed in recent years the possibility of increasing the factor of the output of photovoltaic converters. For example: In the no more than two year period separating the two Lunochods--fundamentally improved solar batteries--new photovoltaic converters were adapted. The resultant benefits in the output allowed the second lunar vehicle, the Lunochod-2, to travel 37 km in four months, while its predecessor, the Lunochod-1, travelled only 10.5 km in over 12 months.

The range of usage life--technical output--of the solar batteries can be quite long. But under space conditions it is decreased as a result of the effects of radiation, micrometeors and the decrease in the shield's transparency. The greatest effect is suffered by batteries installed perpendicularly to the direction of the solar radiation's incidence. Therefore, the special attention of the designers has been turned to a more favorable location for solar batteries in new astronautical equipment and the systems of their spatial orientation.

Satellites, spaceships, and orbital stations (as well as lunar vehicles) often fall in the shadow of the Earth (or the moon). Then, chemical sources of electrical current (accumulators) charged earlier by the solar batteries are used.

Each new space experiment requires something else from solar batteries. In satellites, spaceships and orbital stations, they have to form sheets which stick into space. In the Lunochod lunar vehicles they were situated on a cover fitting tightly over the instrument compartment. We should add that the vehicle had to operate at temperatures which changed from -180°C to +150°C.

The most complex astronautical programs demand corresponding energy requirements for onboard astronautical equipment. One ongoing task is not only the improvement of photovoltaic converters, but also that of the onboard chemical sources of current (accumulators, fuel cells, etc.). But the main role in astronautical energy will certainly be played by heliotechnology.

The onboard spatial orientation system--a two level solar sensor--must operate with very great accuracy (up to three inches), so that the solar batteries of a satellite or spaceship will work with the greatest output (an acceptable error of 3-10 degrees).

The onboard chemical sources of current in astronautical devices are usually accumulators: silver-zinc, silver-cadmium and cadmium-nickel, and fuel cells, electrochemical generators with an output of 30 to 70 percent, and biochemical cells (bacterial).

Onboard physical sources of current in astronautical devices are above all solar bateries with a contact surface of 1-21 m2 with photovoltaic cells (up to 80,000 pieces) and have a unit power of 10-108 W/m2 and an output of 7 to 15 percent. Long term operation in space decreases the power of solar batteries by around 10 percent. Moreover: thermoelectric generators with an output of 1.5 to 18 percent (which directly provide alternating current) with an output of 5-10 percent, thermophotovoltaic generators (experimental) and isotope generators (a 4-6 percent output).

In recent years in the USSR and USA over 1000 solar batteries have been operated with a multiyear period of technical output and power from a few watts to 20 kW and surfaces of up to 40 m^2. The solar batteries are either rigid or--soft--band like. On the basis of the astronautical experience of the USSR and other states, work is being performed on the use of solar batteries for the powering of ground equipment, and even in the home. The reason for this is relatively great efficiency, practically unlimited durability and simplicity of design. One example is the generally accessible Soviet Foton and SBSP solar batteries for the powering of transmission radio receivers and the American Centralab-NASA-210-240. These are batteries composed of silicon photovoltaic cells with dimensions of 10X20 to 20X40 mm, yielding a voltage of around .5V and a current of 60-250 mA per cell. Since 1976, solar batteries have begun to be used experimentally to power flying radio models and the onboard equipment of gliders.

[photograph]--The Soviet manned orbital unit, composed of the Sojuz spaceship and the Salut scientific-research station, powered with electrical energy by solar batteries in the form of sheets sticking out into space.

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