The Operation of the Solar Powered Stirling Engine in Space

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The major requirement for every space system is power. Without portable electrical energy mankind cannot reach into space. Each satellite and space ship launched must have its own internal power supply. The most commonly used energy sources today are small nuclear reactors, panels of photovoltaic cells, and hydrogen/oxygen electrolysis cells. A system that could combine the best of each of these systems would be extremely useful. Such a system is the solar powered Stirling engine. It has the reliability of a nuclear reactor, an unlimited energy source like photovoltaic cells, and is completely clean like electrolysis cells. Unlike these other systems though, the Stirling engine does not need special material or special packaging and is cheap and simple in construction.

The Beale free-piston Stirling engine has only two moving parts, needs no lubricants, seals easily, and is self-starting. These attributes combine to make an ideal space engine. The idealic solar energy collector for this space engine is a parabolic mirror. However, alternative systems can be used. The Getaway Special test version of the engine has two energy collection systems that could be used. Design One is a parabolic mirror and Design Two is a fresnel lense.

In Design One, solar energy for the Stirling engine is collected by a parabolic mirror. The mirror is kept pointed directly at the sun via five photovoltaic cells, a comparator computer chip, and two small motors. As sunlight strikes the solar cells, the comparator computer chip sends signals to the motors to move the mirror until the amount of sunlight striking each solar cell is equal. This keeps the focused point of light in a very stable position. The heating chamber of the engine is mounted in the focal point of the mirror, and the engine is connected to an axel on which it is rotated by one of the motors. The axel is mounted parallel to a plate which is rotated by the other motor. With this configuration the mirror can be centered on the sun for the maximum amount of time. In order to track the sun the mirror must be able to move about freely. Inside the GAS canister it cannot do this, yet, outside it can, and outside more data can be collected. A third small motor will push the engine and mirror out of the canister. To avoid costly and bulky pumps for depressurizing the canister before it opens, purge ports in the canister bottom could be left open. This will allow depressurization at the same rate and time as the cargo bay. The canister can then open safely and the project can continue.

If a canister with an opening is not developed by launch time, Design Two could be used for energy collection. This system uses a fresnel lense mounted beneath a window in the canister top. The engine is mounted in the focal point of the lense and does not move. As the space shuttle orbits the Earth with the cargo bay facing the sun, the fresnel
lense will concentrate all light striking the canister top onto the heat chamber of the engine. Each time the space shuttle passes through the Earth’s shadow the engine will stop and start. The number of orbits will be the number of data recordings made from the engine.

Both designs will use the same specially built Beale free-piston Stirling engine. The piston of the engine will be magnetized and the piston chamber wall will have a copper coil embedded in it. When the piston passes through the coil, an electric current will be generated. This current is what will be measured for data output.

The major flight requirement for both designs is the position of the shuttle in orbit. The shuttle must either have the cargo bay facing away from Earth or facing the sun. All other procedures are completed automatically by the project computer. Control by astronauts is limited to an activate/deactivate switch. After achieving orbit and opening the cargo bay doors, an astronaut activates the project computer and on deorbit or in case of an emergency, the astronaut switches the deactivate button. The activate switch begins data collection and the deactivate switch ceases data collection, turns the engine off, and returns the project to prelaunch status.

The most beneficial aspect of this engine system is its power supply qualities. As a system that converts heat to electricity, the Stirling engine could be an excellent emergency backup system for the space shuttle in case another fuel cell fails, or it could be the permanent power supply for a satellite or space station in L5 or geosynchronous orbit. A lunar base could use a large set of Stirling engines just as well. The Stirling engine has been used on Earth for a number of years, now it is time to use it in space.