Special Project Number 56

Feasibility of Beam-Powered Rover Reactivation
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Special project # 56 assessed the condition of existing hardware that would be used for a demonstrate/proof of concept to beam power using microwave energy.

Products of the project:

1. Inventory of existing components and base line hardware
2. Base Line Hardware Technical Description
3. Electronic Control System Block Schematic
4. Control Box Wiring
5. Cost estimates for refurbishment
6. Program Base Line Test Bed Description
7. Project schedule for base line hardware

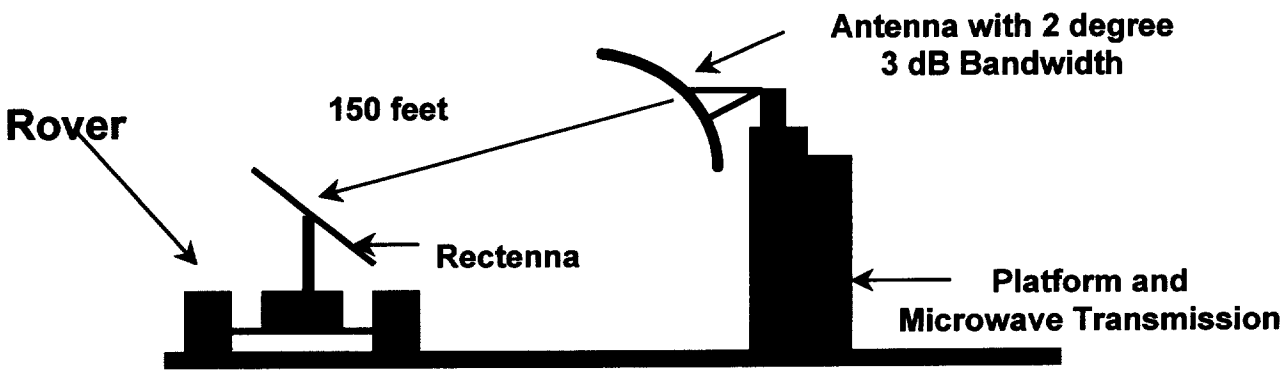
Introduction

Boeing's Reusable Space Systems Advanced Programs Engineering will **demonstrate/proof of concept** for transmission of microwave energy to a remote location and convert that energy into useful electric power.
The demonstration/proof of concept (phase 1) will use existing hardware for a base line. This hardware will need to be reassembled checked out and tested. It is estimated this effect for phase 1 will take about 90 days.
Phase Two of this project will be insertions and applications of Advanced Electronics Technology for power beaming. Phase Two will be analyzing, developing and prototyping hardware for insertion into the base line test hardware.

Base Line hardware is comprised of the following: (Inventory)

- A vehicle/rover (Test Bed) that receives its power from the remote microwave source. The base is a simple Go-Kart's frame and wheels.
- A rectenna to convert RF energy to DC (Part of the rover)
- A microwave transmitter and beacon receiver that can be pointed at the rover
- A beacon transmitter
- HF radio link to control the rover steering and propulsion
- Auxiliary Hardware

Microwave Remote Power Transmission



Base Line Hardware Technical Description

- **Vehicle/Rover (Test Bed)**

The completely self-contained vehicle in Fig. 1 (see next page) includes the tracking rectenna that converts the beamed rf energy to DC power, a drive motor and the electronics. The vehicle/rover can be steered in either direction, forward or reverse using the multi-channel HF radio link.

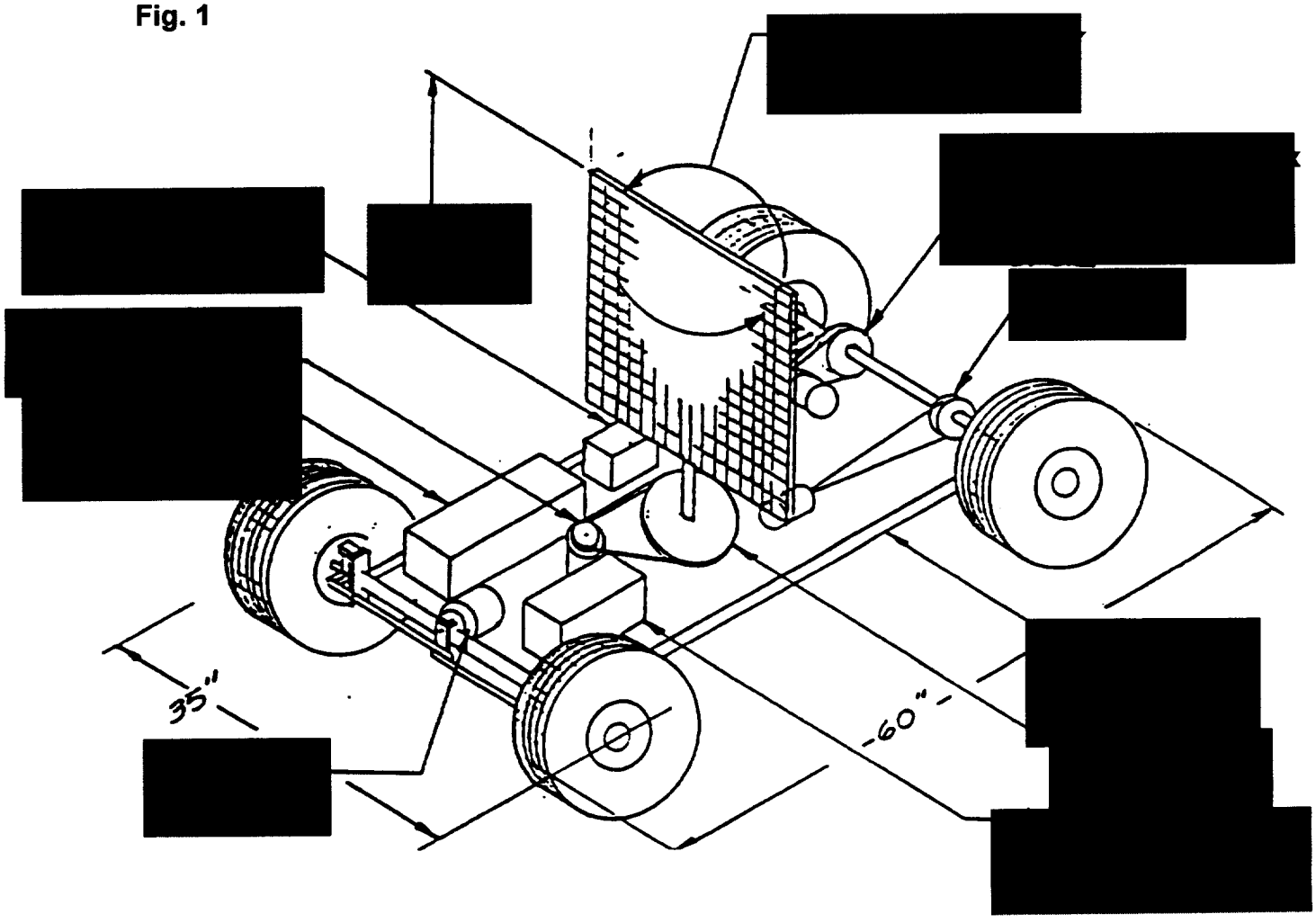
- **Microwave Transmitter**

The transmitter for this system operates in the *ISM (Industrial, Scientific, and Medical – Federal communications Commission Rules and Regulations Part 18 subpart C 18.301 Operating frequencies)* band of 5800+/- 75 MHZ and will deliver and output of 3kW cw. The transmitter includes a Dielectrically Stabilized Oscillator (DSO) driving a Klystron amplifier driving a 6-ft. diameter parabolic antenna.

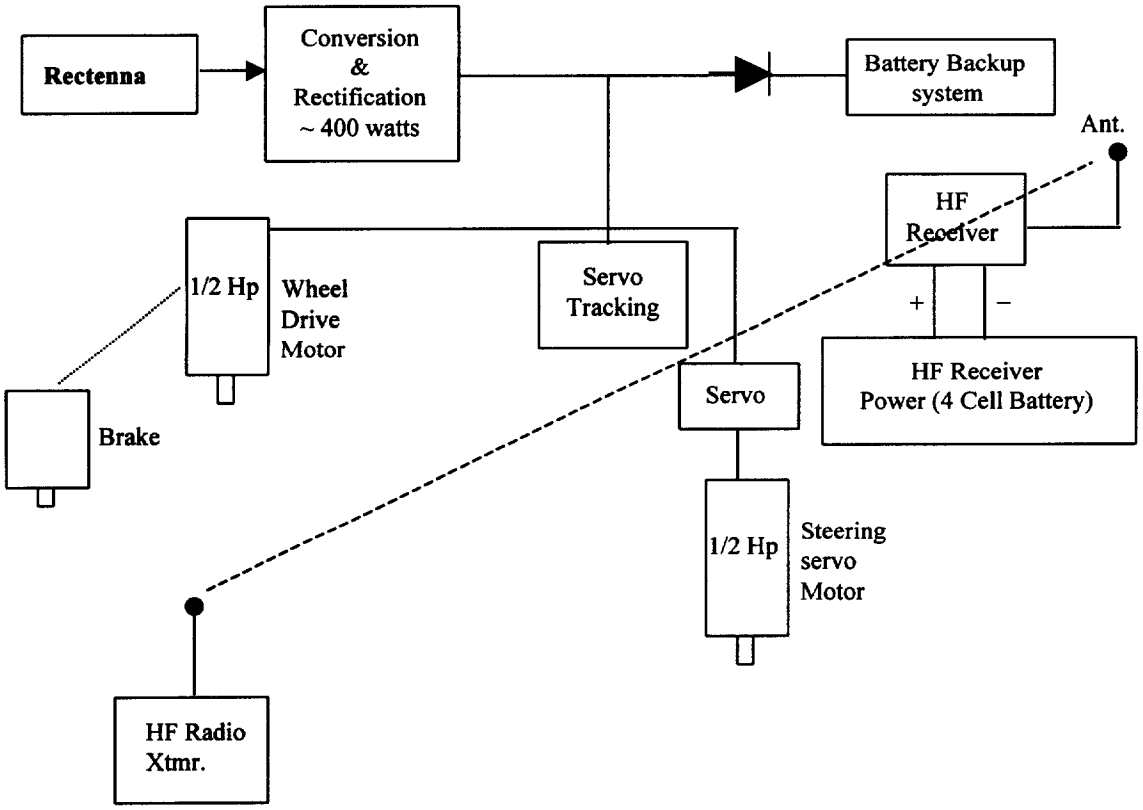
- **Rectifying antenna: Rectenna**

This is the microwave-to-DC energy conversion system. It uses an array of elements, each receives a portion of the transmitted microwave energy and will efficiently convert the RF to DC power. Each element of the array consists of a dipole antenna to receive the microwave energy, a lowpass filter to prevent the retransmission of generated harmonics, a schottky barrier diode to rectify the microwave energy and outfilter to smooth the DC.

Fig. 1



Electronic Control System Block Schematic



The control commands are transmitted to the vehicle over a HF frequency band that is centered at 75 MHz. *(FCC R/C Rule 7 Lists 30 channels in the 75.4-76.0 MHz. Range that may only be used to operate surface craft devices)* total of five communications channels are used. This system uses the pulse-coded modulation technique.

The receiver in the rover will control the various servos and relays. The receiver will be used as the start up mode in the rover's systems. It is powered by the 4 D cell batteries in the control box. The servo and most of the relays are powered by the rectenna source.

Control Box Wiring