Pickup Antennas for Waveguide Motors

A parametric motor energized by radio waves at 425 kHz was first built by Schudner[1] while Stockman[2] was the first to utilize a directive antenna for a radio wave motor operated at 50 mHz.[2] Stockman also analyzed the parametric motor circuit with low-frequency models and found that the differential equation of the motor circuit was a Mathiew-Hill Equation.[3,4] His experimental results of low-frequency parametric motors were also theoretically analyzed by Blasgen and Monson.[5] For the Stockman's radio-frequency motor with a directive antenna, the analysis is yet incomplete.[6] The feasibility and design of a waveguide motor operating on microwave energy has been reported previously by Garnier and Ishii.[7,8,9] Recent investigation by Sedivy[10] revealed that the differential equation of torque for the "microwave motors" is not a Mathiew-Hill equation. The purpose of this correspondence is to present the effect of various pickup antennas on the waveguide motors[9] speed vs. input power relationship at frequencies of 2.56, 3.0 and 3.44 GHz.

As shown in Fig. 1, the motor tested utilized a concentric-wound coil of 2000 turns of number 34 enameled wire which had a resistance of 85 ohms. The antenna tested (see Figs. 2–5 for various configurations) was inserted inside the waveguide to pickup the microwave energy which was then rectified and fed to the coil. The pickup antennas were designed in a plug-in style so that they were interchangeable. The coil was centered in a dc magnetic field of 1.4 kilogauss as shown in Fig. 1. Measurements were made by initially adjusting the standing wave for maximum speed of the motor and then decreasing the input power in incremental steps. The reflected power was also recorded at each step and the rpm was measured using a photocell activated electronic frequency counter.

The motor speed vs. input power curve at each frequency for pickup antennas 1 through 4 is shown in Fig. 2–5, respectively. The maximum rpm occurred in each case when the difference in incident and reflected power was greatest, and as the difference decreased the rpm decreased. Referring to the curves, the rpm of the motor decreased as frequency increased when using antennas 1 and 4, and increased as frequency increased using antennas 2 and 3. While the reason for this is not clear to the author at this moment, it was noted that antennas 2 and 3 are similar as are antennas 1 and 4.

Analysis of the above shows that the number of reflectors on antennas 2 and 3 caused the difference found in the frequency-speed relationship and that the best efficiency, and also the highest speed recorded (411 rpm), occurred when using antenna 4 with a signal frequency of 2.56 GHz. Also that the rpm of the motor is dependent on both the transmitted frequency and the pickup antenna configuration.

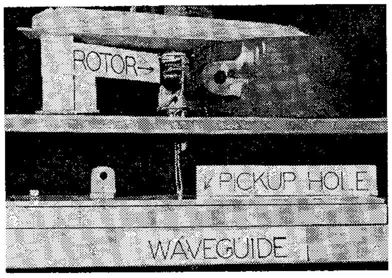

Fig. 1. Configuration of a waveguide motor.

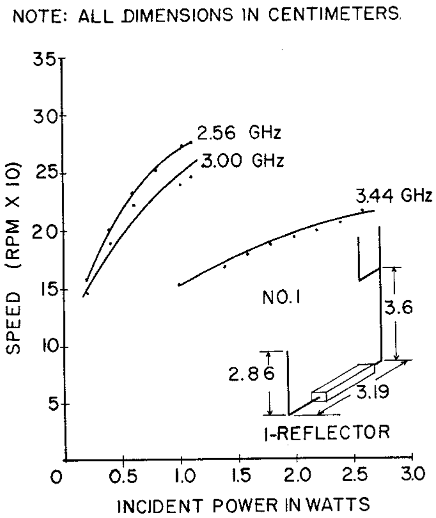

Fig. 2. Motor speed vs. input power–antenna no. 1.

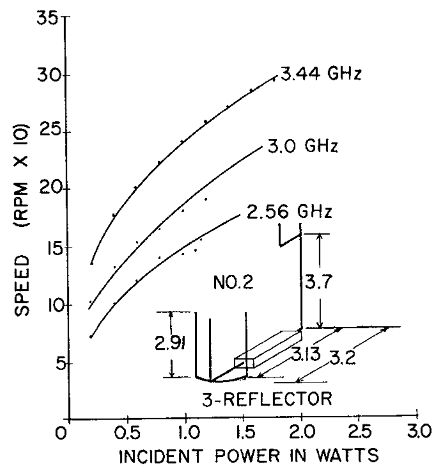

Fig. 3. Motor speed vs. input power–antenna no. 2.

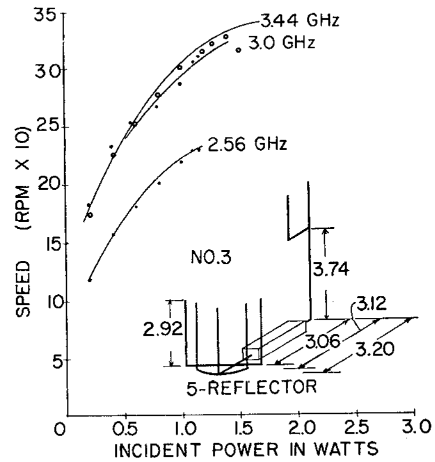

Fig. 4. Motor speed vs. input power–antenna no. 3.

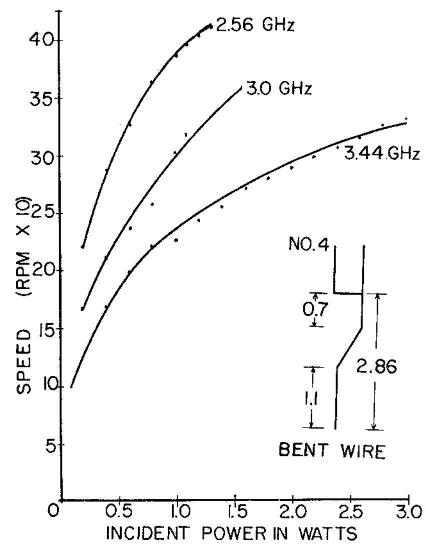

Fig. 5. Motor speed vs. input power–antenna no. 4.

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