news

MicroWaves 9(11):14, (Nov 1970)

Can microwaves deliver power?

Electricity from solar power satellite proposed. Project deemed possible, but requires major advances in technology.

Justin Blazer Scott
News Editor

Take two hundred 50-megawatt microwave tubes and a 1.5 mile diameter antenna with pointing accuracy to less than one half second of arc. Orbit them 22,300 miles in space. Then build a ground station with a six mile square receiving antenna, capable of rectifying ten thousand megawatts of microwave energy to dc at 85% efficiency. Throw in a major advance in the techniques of converting solar energy to electric power and myriad breakthroughs in space travel and mechanical engineering. Sprinkle liberally with money, and you'll come up with something that will (1) end fossil fuel pollution of the earth and (2) place the microwave industry in a position currently enjoyed by middle eastern sheiks and oil burner repairmen.

A solar power satellite system in synchronous orbit was proposed by Dr. Peter E. Glaser, head of engineering sciences at Arthur D. Little, Inc., Cambridge, Mass., at the International Microwave Power Institute's (IMPI) Fifth International Symposium on Microwave Power Applications held last month in Scheveningen, The Netherlands. A solar collector, 5 miles square, would convert solar energy to dc and send it along a two-mile superconducting transmission line to a microwave generating station. Microwave energy could be beamed to an earth receiving station which would convert it back to dc.

"An alternative has been proposed to utilize solar energy to produce significant amounts of power without pollution," Glaser said. He suggested that a system producing 10,000 megawatts might supply a major population center.

Glaser and several other authors discussed some of the immense microwave developments that must be achieved to implement the system: (1) high-efficiency convergent beams that will require aperture illumination above the 70 per cent efficiency presently found in radar and communications; (2) 50 to 500 megawatt amplitrons or crossed field amplifiers with over 90 per cent efficiency; (3) a rectifier that can convert 10,000 megawatts of microwave energy to dc at 85 per cent efficiency—52 per cent is the best yet demonstrated.

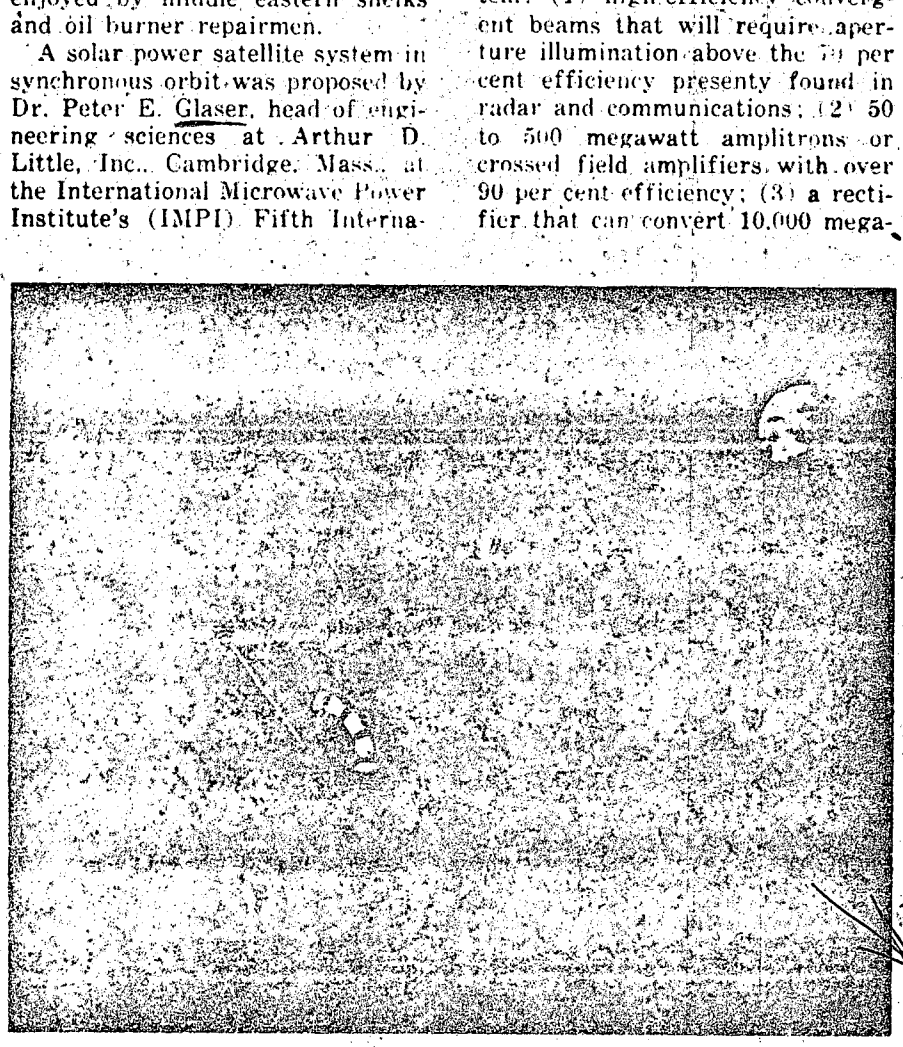
"To transmit microwave power, advances in the areas of convergent beams and high-energy density detector technology at shorter wavelengths are needed," said W. J. Robinson, Jr., of Marshall Space Flight Center, Huntsville, Ala. Referring to NASA experiments in space, he indicated that with present technology, 3 GHz is the most efficient frequency for power transmission.

Atmospheric attenuation of microwave power was discussed by Vincent J. Falcone, Jr., of the Air Force Cambridge Research Laboratories, Hanscom Field, Bedford, Mass. He concluded that "for power densities of 0.01 W/cm², the optimum wavelength region of transmission of microwave power through the earth's atmosphere is the 10 cm region (3 GHz)." Falcone reported that in complete cloud cover and moderate rainfall (conditions that occur about 14 per cent of the time) attenuation is least at 3 GHz.

But 3 GHz complicates the job of generating and transmitting vast microwave powers by conventional technology. According to William C. Brown of the Microwave and Power Tube Div. of Raytheon Co., Waltham, Mass., a large array of 50-megawatt crossed field devices could be used to generate continuous microwave power if the frequency could be kept down around 915 MHz. However, higher frequency and/or power, he noted, would probably mean that "the crossed-field device would need to utilize a new microwave circuit concept which would provide interaction areas two or three orders of magnitude greater than now exist in crossed-field amplifiers."

"A large non-directive aperture several square miles in area made from many small receiving apertures each terminated in an efficient solid-state rectifier" could capture and rectify the microwave energy, according to Brown.

Both Glaser and Brown feel that the large size of the receiving antenna will mean that power densities are low (0.01 watt per square centimeter), minimizing the radiation hazards, provided living beings are kept out of the beam.



Proposed solar power satellite station might supply power to run a major city.