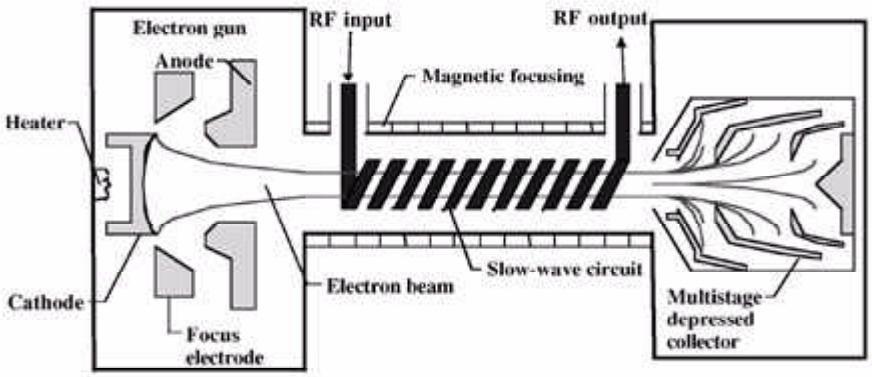
Technique Developed for Optimizing Traveling-Wave Tubes



Traveling-wave tube.

A traveling-wave tube (TWT) is an electron beam device that is used to amplify electromagnetic communication waves at radio and microwave frequencies. TWT's are critical components in deep-space probes, geosynchronous communication satellites, and high-power radar systems.

Power efficiency is of paramount importance for TWT's employed in deep-space probes and communications satellites. Consequently, increasing the power efficiency of TWT's has been the primary goal of the TWT group at the NASA Lewis Research Center over the last 25 years.

An in-house effort produced a technique (ref. 1) to design TWT's for optimized power efficiency. This technique is based on simulated annealing, which has an advantage over conventional optimization techniques in that it enables the best possible solution to be obtained (ref. 2). A simulated annealing algorithm was created and integrated into the NASA TWT computer model (ref. 3). The new technique almost doubled the computed conversion power efficiency of a TWT from 7.1 to 13.5 percent (ref. 1).

The algorithm can be readily modified so that any calculable TWT characteristic can be optimized with respect to any combination of input design parameters. This has enabled TWT's to be optimally designed for important characteristics for which there were previously no design optimization methodologies. For example, in one version, the technique has been used to design a TWT for optimized overall power efficiency, which is extremely important for TWT's used on deep-space probes and communications satellites. This design incorporates both the conversion power efficiency from the electron beam to the microwave signal and the energy collected from the ‘"spent" beam in the multistage-depressed collector (see the illustration). In another version, the technique was used to optimize the power over a wide frequency bandwidth instead of at just a single frequency. This will substantially increase the data transmission volume capability of TWT's. In yet

another version, the technique was used to design a TWT with both high conversion power efficiency and low signal distortion.

References

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Lewis contact: Dr. Jeffrey D. Wilson, (216) 433-3513, Jeffrey.D.Wilson@grc.nasa.gov
Author: Dr. Jeffrey D. Wilson

Headquarters program office: OSS
Programs/Projects: Deep Space Network Upgrade.
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