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Preface

The phrase "high technology" is perhaps one of the more overused descriptions in our technical vocabulary. It is a phrase generally reserved for discussion of integrated circuits, fiber optics, satellite systems, and computers. Few people would associate high technology with vacuum tubes. The notion that vacuum tube construction is more art than science may have been true 10 or 20 years ago, but today it's a different story.

The demand on the part of industry for tubes capable of higher operating power and frequency, and the economic necessity for tubes that provide greater efficiency and reliability, have moved power tube manufacturers into the high-tech arena. Advancements in tube design and construction have given end users new transmitters and RF generators that allow industry to grow and prosper.

If you bring up the subject of vacuum tubes to someone who has never worked on a transmitter or high-power RF generator, you are likely to get a blank stare and a question: "Do they make those anymore?" Although receiving tubes have more-or-less disappeared from the scene, power tubes are alive and well and are performing vital functions in thousands of divergent applications. Solid-state and tube technologies each have their place, each with its strengths and weaknesses. It should be noted that even receiving tubes are staging somewhat of a comeback in high-end audio applications.

Tube design and development, although accompanied by less fanfare, is advancing as are developments in solid-state technology. Power tubes today are designed with an eye toward high operating efficiency and high gain/bandwidth properties. Above all, a tube must be reliable and provide long operating life. The design of a new power tube is a lengthy process that involves computer-aided calculations and advanced modeling.

Despite the inroads made by solid-state technology, the power vacuum tube occupies—and will continue to occupy—an important role in the generation of high-power radio frequency energy in the high-frequency regions and above. No other device can do the job as well. Certainly, solid-state cannot, especially if cost, size, and weight are important considerations.

The field of science encompassed by power vacuum tubes is broad and exciting. It is an area of growing importance to military and industrial customers, and a discipline in which significant research is now being conducted.

Power vacuum tubes include a wide range of devices, each for specific applications. Devices include power grid tubes (triodes, tetrodes, and pentodes) and microwave power tubes (klystrons, traveling wave tubes, gyrotrons, and numerous other high-frequency devices). Research is being conducted for both tube classes to extend output power and maximum frequency, and to improve operating efficiency.

This book examines the underlying technology of each type of power vacuum tube device in common use today and provides examples of typical applications. New development efforts also are reported, and the benefits of the work explained.

This Second Edition of *Power Vacuum Tubes* is directed toward engineering personnel involved in the design, specification, installation, and maintenance of high-power equipment utilizing vacuum tubes. Basic principles are discussed, with emphasis on how the underlying technology dictates the applications to which each device is dedi-

cated. Supporting mathematics are included where appropriate to explain the material being discussed. Extensive use of technical illustrations and schematic diagrams aid the reader in understanding the fundamental principles of the subject.

Today's modern power tube is unlike the power tubes in use a decade ago. And with the trend in industry toward operation at higher power levels and higher frequencies, the vacuum tube is certain to remain on the scene for a long time to come.

Jerry C. Whitaker

About the Author

Jerry Whitaker is a technical writer based in Morgan Hill, California, where he operates the consulting firm *Technical Press*. Mr. Whitaker has been involved in various aspects of the communications industry for more than 20 years. He is a Fellow of the Society of Broadcast Engineers and an SBE-certified Professional Broadcast Engineer. He is also a member and Fellow of the Society of Motion Picture and Television Engineers, and a member of the Institute of Electrical and Electronics Engineers. Mr. Whitaker has written and lectured extensively on the topic of electronic systems installation and maintenance.

Mr. Whitaker is the former editorial director and associate publisher of *Broadcast Engineering* and *Video Systems* magazines. He is also a former radio station chief engineer and TV news producer.

Mr. Whitaker is the author of a number of books, including:

- *AC Power Systems*, 2nd Edition, CRC Press, 1998.
- *DTV: The Revolution in Electronic Imaging*, McGraw-Hill, 1998.
- Editor-in-Chief, *NAB Engineering Handbook*, National Association of Broadcasters, 1998.
- Editor-in-Chief, *The Electronics Handbook*, CRC Press, 1996.
- Coauthor, *Communications Receivers: Principles and Design*, McGraw-Hill, 1996.
- *Electronic Displays: Technology, Design, and Applications*, McGraw-Hill, 1994.
- Coauthor, *Interconnecting Electronic Systems*, CRC Press, 1992.
- Coeditor, *Television Engineering Handbook*, revised edition, McGraw-Hill, 1992.
- Coeditor, *Information Age Dictionary*, Intertec/Bellcore, 1992.
- *Maintaining Electronic Systems*, CRC Press, 1991.
- *Radio Frequency Transmission Systems: Design and Operation*, McGraw-Hill, 1990.
- Coauthor, *Television and Audio Handbook for Technicians and Engineers*, McGraw-Hill, 1990.

Mr. Whitaker has twice received a Jesse H. Neal Award *Certificate of Merit* from the Association of Business Publishers for editorial excellence. He also has been recognized as *Educator of the Year* by the Society of Broadcast Engineers.

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This book is dedicated to my daughter
Alexis Ann Whitaker
My greatest joy is watching you grow up