

ELECTRICAL ENGINEERING TEXTS

---

# THEORY OF THERMIONIC VACUUM TUBES

FUNDAMENTALS—AMPLIFIERS—DETECTORS

BY

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## PREFACE

This book is based on the author's lecture notes for a course on vacuum tubes given at Harvard University since 1922. As the preparation of the manuscript progressed, it became apparent that not all of the material could be contained in a single book. Consequently, only the theory of the operation of vacuum tubes at low power is presented here; the remaining material, including the theory of power amplifiers and oscillators, gas-content tubes, rectifiers, etc., will, according to present plans, appear in a second book.

Although this book is written primarily as a textbook, it is hoped that it will serve also as a reference book. The author has endeavored to present only the fundamental principles of the subject, avoiding discussion of the multifarious circuits in which the vacuum tube may be used. The circuits and applications of vacuum tubes change from year to year but the fundamental theory is the same for all time. With an understanding of the principles, any circuit and any application can be analyzed.

Certain sections, which go into considerable detail, may to advantage be omitted on the first reading of the book. For the guidance of the reader these sections are indicated by an asterisk(\*).

The author takes this opportunity to express his gratitude to his wife, always a companion, coworker, and inspiration in the preparation of the manuscript; to David P. Wheatland who so generously assisted in collecting experimental data and in reading the proofs, and to all others who have aided in various ways. The author wishes especially to acknowledge his obligation to Prof. H. E. Clifford, Dean of the Harvard Engineering School, for his many valuable suggestions and corrections in editing the manuscript.

E. L. C.

CRUFT LABORATORY, CAMBRIDGE.  
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A vacuum tube, an electron tube, or valve (British usage) or, colloquially, a tube (North America), is a device that controls electric current flow in a high vacuum between electrodes to which an electric potential difference has been applied. The type known as a thermionic tube or thermionic valve uses the phenomenon of thermionic emission of electrons from a heated cathode and is used for a number of fundamental electronic functions such as signal amplification and current rectification. Vacuum tubes using oxide coatings are used for most small vacuum tubes / thermionic valves using voltages up to a few thousand volts. Although, normally vacuum tubes are indirectly heated these days, this form of heating is less efficient than the directly heated option. As a result, some specialist tubes or valves that use tungsten or thoriated tungsten filaments sometimes use direct heating techniques. Variation of electron emission with temperature for different emitters. Space charge. One important aspect of vacuum tube theory is the space charge. The electrons flowing between the cathode