

INSIDE THE VACUUM TUBE

BY

JOHN F. RIDER

Lt. Col. U. S. Signal Corps, (Ret.)



Illustrated by
Baxter Rowe

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AUTHOR'S FOREWORD

OF ALL THE INVENTIONS that have ever made scientific history, the discovery by Lee DeForest that a few turns of wire in between the two elements of a diode vacuum tube were able to control the flow of electrons, can without doubt be classed as among the foremost in its benefits to mankind. Not only has the three-element vacuum tube been the means of providing entertainment and education to millions of people throughout the world, but it has proved to be the keystone in the arch upon which has been built innumerable branches of scientific thought.

Considering the effect of these few turns of wire—the grid in a triode—on the transmission and reception of intelligence through the medium of radio communication alone, to put it mildly, this discovery was tremendous. Of course, the discovery of the high-frequency alternator by Alexanderson and the arc transmitter by Poulson made possible the exchange of intelligence by radio, yet this means of communication was limited in that it did not possess the versatility of electronic apparatus typified by the vacuum tube. The advent of the triode vacuum tube as an ancestor for the vast number of different types that we know today, was really a beginning of a new era in world thought. Where would television, facsimile, radio broadcasting, and radar be without it? The answer is obvious. . . .

In view of all this, it was felt that this book was a necessity and it has but one purpose: to present a solid, elementary concept of the theory and operation of the basic types of vacuum tubes as a foundation upon which can be built a more advanced knowledge of tubes in general. Here then are the elements—the rest is up to the reader. . . .

We have set certain boundaries in this book so that its scope may be considered limited to some degree, but after all—and we repeat—this is an *elementary* explanation of vacuum tube behavior and operation. We have kept the essential mathematics in as simple a form as possible and have included only the minimum amount. In the final chapter, we have omitted mention of certain types of tubes, for instance the light-house tube, the magnetron, and the klystron, because even a superficial description of their functioning would involve matters which were con-

sidered to be beyond the limits which had been set. So also did we omit the subject of reactive loads in our discussion of this important phase of tube functioning, because its inclusion would take us over those boundaries of elementary study.

The reader will find several innovations in this book. Following the explanation of the electron theory, is a new presentation of text concerning the vacuum tube: a discussion of electrostatic fields. It is our feeling that by understanding the distribution and behavior of the fields within a tube, the reader will gain a better picture of why amplification is accomplished within a tube and how the grids and plate are inter-related. Throughout the book, which covers diodes, triodes, tetrodes, and pentodes, the aim is to present a clear physical picture of exactly what is occurring in a vacuum tube, inclusive of the development of characteristic curves of all kinds, load lines, and dynamic transfer characteristics, discussion on power amplifiers, the use of pentodes as triodes, the cathode follower, etc.

One of the problems in book making has been to make illustrations easily accessible to the text describing or discussing them. We have, therefore, had certain diagrams and graphs printed on both sides of the page so that they can be consulted with a minimum of bother to the reader while reading the text referring to them.

Another innovation in the publishing of radio texts is the use of line anaglyphs that provide three-dimensional pictures which up to now have been presented in one plane only. We have used but three of these stereoscopic illustrations, because we believe that if the reader once gets the idea of a field, for instance, from an anaglyph, he can imagine how it appears under other conditions from a drawing in one plane.

We wish to express our gratitude to the RCA Manufacturing Co. for their cooperation in providing us with the hitherto unpublished data on the 6SJ7 pentode with low screen-grid voltages, among others. Also we wish to thank the General Electric Co. and other firms for their kind cooperation. Our gratitude is expressed to Mr. Robert Lorenzen and Mr. G. C. Baxter Rowe for their contribution to this text and their conscientious criticism, and to Mr. Louis Prior for his valuable suggestions and graphical drawings.

JOHN F. RIDER

September, 1945

VIEWING THE ANAGLYPHS

The three two-colored anaglyphs facing pages 9, 37, and 122, must be viewed through the red and blue spectacles that will be found in an envelope fastened to the inside back cover. Hold the spectacles close to the eyes with the blue filter over the right eye and the red over the left eye. For a person with normal eyesight, the stereoscopic effect will be obtained with the page held at ordinary reading distance; this distance may vary for persons whose vision is not normal and uncorrected.

In the case of anyone who may be color blind, he may be unable to see the stereoscopic effect, depending on the degree and nature of the visual defect. In such event, looking at an anaglyph with one eye through one of the filters will enable him to see the illustration in at least two dimensions.

TABLE OF CONTENTS

- CHAPTER 1. INTRODUCING THE ELECTRON—1. The Electron—2. The Atomic Theory—4. Matter Can be Transformed—6. The Atom—7. The Molecule—8. The Atom Too is a Structure—9. The Modern Idea—11. Conductors and Insulators—13. Ions and Ionization—13. Atomic Spacing—16.
- CHAPTER 2. ELECTRON EMISSION—19. Electron Emission Caused by Energy Conversion—21. Thermionic Emission—24. The Indirectly Heated Cathode—26. Types of Electron Emitters—27.
- CHAPTER 3. MOVEMENT OF CHARGES—30. The Positive Ion—32. The Negative Ion—33. Laws of Attraction and Repulsion—34. Electrostatic Fields—35. Radial and Parallel Electrostatic Fields—36. Direction of Lines of Force—37. Forces Present in the Radial Electrostatic Field—38. Electrostatic Field Between Parallel Plates—39. Distribution of Charges—41. The Force Between Two Parallel Plates—43. Relation of Force, Voltage, and Plate Separation—45. Controlling the Force by a Third Charged Body—47.
- CHAPTER 4. SPACE CHARGE AND PLATE CURRENT—51. Electrons Leave the Cathode—52. Electrons in Space—53. Space Charge—55. Density of Space Charge—56. Current is Space-Charge-Limited—58. Plate Current—58. Fields Between Cathode and Plate—61. Electrons To and From the Space Charge—62. Negative Voltage upon the Plate—64.
- CHAPTER 5. FUNDAMENTALS OF TUBE CHARACTERISTICS—66. Vacuum Tube Relationships—67. Characteristic Curves—68. Expression of Relationship of Characteristic Curves—70. Characteristics Have Two Variables—71. Linear and Non-Linear Characteristics—73. Static and Dynamic Characteristics—75. Number of Characteristics for Each Tube—76. Families of Curves—77. Resistance Within a Vacuum Tube—78. Power in Vacuum Tubes—79.
- CHAPTER 6. THE DIODE—81. Cathode and Filament Structure—83. Directly and Indirectly Heated Tubes—83. Function of the Diode—87. Electron Flow and Current Flow—87. Plate Current in the Diode—89. Contact Potential—91. Determination of Diode Behaviour—92. Emitter Temperature—Plate Current Characteristic—92. Plate Voltage—Plate Current Characteristic—96. Resistance of the Diode—99. D-C Plate Resistance of the Diode—100. A-C Plate Resistance of the Diode—104. Static and Dynamic Diode Characteristics—107. A-C Applied to the Diode Plate—110.

- CHAPTER 7. THE TRIODE—112. Grid Structure—113. The Function of the Triode—114. Input and Output Circuits of the Triode—115. The Triode Operating Potentials—117. Electrostatic Fields in the Triode—119. Negative Voltage on the Grid—120. Positive Voltage on the Grid—124. Zero Voltage on the Grid—127. "Free" Grid—128. Summary of Voltages Applied to the Grid—130. Why the Grid Bias—131.
- CHAPTER 8. STATIC CHARACTERISTICS OF TRIODES—136. Triode Circuit Element Notations—137. Grid Voltage—Plate Current Characteristic Curves—139. How the Curve is Developed—139. How the Curve is Used—143. The Point of Operation—145. $E_c - I_p$ Curve for Tungsten-Filament Tube—147. Grid Family of Characteristic Curves—151. What the Grid Family of Curves Shows—155. Plate Voltage—Plate Current Characteristics (Static Plate Family)—156. Tube Constants—160. Amplification Factor—161. Determining the Amplification Factor—162. Determining μ from the Plate Family—165. Amplification Factor of Triodes—167. Plate Resistance—167. Finding the A-C Plate Resistance—168. Using the Plate Family in Finding A-C Plate Resistance—171. Transconductance—173. Transconductance from Grid Family—174. Importance of Transconductance—175. Transconductance from Plate Family—177. Relation Between g_m , r_p , and μ —179. Interdependence of g_m , r_p , and μ —182.
- CHAPTER 9. TRIODE DYNAMIC CHARACTERISTICS AND LOAD LINES—185. General Load Effects—186. The Basic Triode Circuit—187. Plate and Load Resistances in Series—189. The Plate Voltage, e_b —190. The Effect of the Load—191. Varying the Grid Voltage—191. Introducing the Load Line—193. Resistances Graphically Represented—193. Linear and Non-Linear Resistances—197. Load Line Construction—198. Meaning of the Load Line—199. Dynamic Transfer Characteristic—203. Construction of Dynamic Transfer Characteristic—204. The Value of the Load Resistor—207. Effects of Different Loads—208. Effects of Resistance on Dynamic Transfer Characteristics—213.
- CHAPTER 10. DYNAMIC TRANSFER CHARACTERISTICS—217. Electrode Voltages Determine Fields—218. Influence of Grid Voltage on Plate Current—219. Initial Operating Point and Quiescent Value of Plate Current—221. Location of the Operating Point—222. Magnitude of the Signal Voltage—226. Output Plate Current and Input Signal Voltage—229. Graphical Representation of Input Voltage and Output Current—229. Comparison of Input and Output Waves—233. Similarity of Output Current to A-C Wave—235. Variation of Amplitude of A-C Wave with Time—236. Non-linearity of Characteristic Causes Distortion of Output—239. Operation on Linear Portion of Characteristic—240.
- CHAPTER 11. VOLTAGE AMPLIFICATION—244. Computing the Instantaneous Plate Voltage—245. Graphical Method of Finding Instantaneous Plate Voltage—246. The Voltage Amplification A_v —250. Determining Voltage Amplification Graphically—251. The A-C Components—252.

- Plate Circuit Theorem—254. Determining Voltage Amplification—256. Input and Output Phase Relationships—261. Optimum Value of Load Resistor—268. Phase Relations Again—269. When the Grid Swings Positive—271. Influence of the Grid Resistor—274. Production of Square Waves—279.
- CHAPTER 12. THE TETRODE AND PENTODE VACUUM TUBES—281. The Tetrode—282. Tetrode Characteristic Curves—287. The Pentode Suppressor Grid—294. Pentode Plate Family—296. Amplification Constant—298. Plate Resistance—298. Transconductance—298. Load Resistor—299. Voltage Amplification—300. Screen-Grid Voltage—301. Plate Load Resistor—306. Typical Pentode Characteristics—311. Pentodes Connected as Triodes—316.
- CHAPTER 13. THE CATHODE CIRCUIT—317. Self-Bias—318. Effect of Unbypassed Cathode Resistor—319. Cathode Resistor Bypass Condenser—321. Determining Value of Cathode Resistor—322. Plate Family for Tube with Unbypassed Cathode Resistor—327. The Cathode Follower—332.
- CHAPTER 14. POWER AMPLIFIERS—339. Definition of Power—340. Plate Dissipation—341. Other Boundaries—345. Power Output—345. Distortion—347. Power Output vs. Plate Dissipation—347. Pentode Power Amplifier—352. Beam Power Tube—356.
- CHAPTER 15. MISCELLANEOUS VACUUM TUBES—361. Vacuum Tube and Tube Socket Construction—362. Vacuum Tube Designations—368. Multi-Purpose Tubes—373. Variable Mu or Supercontrol Tube—375. Acorn Tubes—379. Cathode-ray Tubes—382. Visual Indicator Tubes—393. Gas-Filled Tubes—396. Photoelectric Cells—400.
- APPENDIX. Typical Plate Voltage—Plate Current Characteristic Curves—405. Letter Symbols—406.