CONTENTS

CHAPTER PAGE

1. THE FUNDAMENTAL PARTICLES 1

Early history. Theories of atomic structure. The electron. Other particles of matter. Units.

ELECTRON BALLISTICS 7

Dynamics of a particle. Acceleration of an electron in an electric field. Velocity of an electron in an electric field. Energy acquired by an electron. Sources of energy—current flow. The electron-volt. Initial velocity perpendicular to the field. Millikan's measurement of the electronic charge. Electron in a magnetic field. Thomson's measurement of e/m. The mass spectrograph. The cyclotron. Parallel electric and magnetic fields—focusing. Perpendicular electric and magnetic fields. The magnetron. Velocity modulation of an electron beam. Mapping of nonanalytic fields. Effect of the relativistic change in mass.

3. THE CATHODE-RAY TUBE. 39

Electrostatic focusing. The electron gun. The cathode-ray tube. Electric deflection of the cathode-ray beam. Energy sources of the cathode-ray beam. Magnetic deflection of the cathode-ray beam. Fluorescent screens. Anode voltages. Frequency limitations. The complete oscillograph.

4. THERMAL AND FIELD EMISSION OF ELECTRONS . . 55

Electronic behavior in metals. Free electrons—current flow in metals. The energy barrier at the metal surface. The work function. Emission equations. Average energy of emitted electrons. Contact potential. Cathode materials and construction. Cathode temperatures. The Schottky effect. High-field emission.

5. SPACE CHARGE IN VACUUM TUBES. 80

Experimental determination of current in a diode. Field conditions at the cathode surface. The space-charge equation. Departures from theory. Transit time. Power loss in the diode.

6. DIODE RECTIFIERS. 94

Volt-ampere relations—plate resistance. The half-wave vacuum diode with resistance load. The full-wave circuit with resistance load. Ripple factor. The shunt-capacitor filter. The series-inductor filter. The full-wave rectifier with L-section filter. Critical value of filter input inductance. The full-wave rectifier with π-section filter. Voltage doublers. Choice of tubes.

7. THE VACUUM TRIODE. 128

The function of the grid. Vacuum-tube nomenclature. Graphical characteristics. Triode coefficients. Wave form distortion in vacuum tube circuits. Amplifier classification.

CONTENTS

CHAPTER PAGE

8. THE TRIODE AMPLIFIER—SMALL SIGNALS 146

The series-equivalent circuit. The parallel-equivalent circuit. Vacuum-tube amplifiers. The decibel, unit of power level. The resistance-coupled amplifier. Generalized gain equations. Transformer-coupled amplifiers. Frequency response of transformer-coupled amplifiers. Input admittance of a triode. Transit-time effects. Feedback in amplifiers. Negative feedback. Negative-feedback circuits. The cathode-follower circuit. The grid-bias *R-C* circuit. Measurement of the triode coefficients.

9. MULTI-ELEMENT TUBES 192

Difficulties with the triode. The tetrode. Difficulties with the tetrode. The pentode. The equivalent circuit of a pentode. The beam tube. The variable-*mu* tube. The *magic-eye* tube. Special-purpose tubes.

10. THE AMPLIFIER—LARGE SIGNALS 207

Graphical analysis—the load line. Performance calculations from the load line. The class-*A* power amplifier—triodes. The class-*A* power amplifier—pentodes and beam tubes. Output circuits. Determination of amplitude distortion. Cross-modulation distortion. Plate-circuit efficiency. Plate dissipation. The plate load for maximum power output. Dynamic shift of the *Q* point. The push-pull class-*A* amplifier. Graphical analysis of the push-pull amplifier. The class-*AB* push-pull amplifier. The class-*B* push-pull amplifier. Amplifiers with reactive loads.

11. SECONDARY EMISSION 248

The nature of secondary emission. Secondary-emission surfaces. Secondary-emission efficiency. Current multiplication. Photoelectric electron multipliers. Thermionic multipliers.

12. GASEOUS CONDUCTION. . . . . .

The Bohr atom. The first Bohr postulate—energy of an orbit. The second Bohr postulate—the quantum theory. The third Bohr postulate—radiation. Excitation, ionization, recombination. Metastable states. Mean free paths. The gas discharge between cold electrodes. Conditions in the discharge.

13. GAS DIODES. . . . . .

Formation of the arc. The thermionic cathode in a gas tube. Hot-cathode gas diodes. Mercury-arc rectifiers. Arc-back in gas tubes. Gas-tube ratings and definitions. Half-wave gas diode rectifier—resistance load. Full-wave gas-diode rectifier—resistance load. The bridge rectifier. Parallel operation of gas diodes. Effect of transformer leakage inductance. Polyphase rectifiers. The three-phase half-wave rectifier. Three-phase half-wave zigzag rectifiers. Six-phase half-wave rectifier. Three-phase full-wave rectifier. Transformer utilization factor. Summary—polyphase rectifiers with resistance load. Polyphase rectifiers with inductance filters. Rectifier circuit design. Over-all efficiency. Glow tubes. Gaseous-discharge light sources.

14. GAS CONTROL TUBES AND CIRCUITS. 329

Action of the grid—the grid ion sheath. The thyratron or gas triode. Deionization. Thyratron control of alternating current. Bias or amplitude control. Phase-shift control. Bias-phase control. Thyratron firing

CHAPTER PAGE

circuits. Shield-grid thyratrons. Thyratron applications. Grids in mercury-pool cathode tubes. The ignitron. Ignitron circuits. Ignitron ratings. Inverters. Cold-cathode gas triodes.

15. PHOTOELECTRIC EMISSION 362

The photoelectric effect—the corpuscular theory of light. The Einstein equation. Threshold frequency. Cathode materials and color response.

16. PHOTOELECTRIC CELLS 369

Photoelectric cell classification. Sensitivity definitions. The vacuum photoemissive cell. The gas-filled photoemissive cell. Calculation of output. Color response of typical surfaces. Photoemissive cell applications. Photovoltaic cells. Photoconductive cells.

APPENDIX 383