Contents

COKEWOKD		V
Preface		vii
Chapter 1 /	General Introduction	
	Objectives	1
	Limitations of Treatment	2
	Significance of Restriction "Narrow Angle"	4
	List of Symbols in Main Text	6
	Definitions and Comments Thereon	8
	Normalization Techniques	10
	Concept of Similar Operating Points	11
	Suggested Preliminary Reading	12
	PART 1 / THE EXPERIMENTAL DATA	
Chapter 2	The Modulation Characteristic	
	Objectives	15
	The Cutoff Voltage and Its Significance	16
	The Total Cathode Current, $I_{c 0}$, at $V_g = 0$	17
	Determination of the Total Cathode Current I _c at Any	
	Value of Grid Bias	17
	The μ and K Values	19
	Effect of Grid Thickness	23
	Accuracy of the Formulas Applicability to Different Triode Constructions	23 24
	The Tetrode Construction	24
	Associated Literature	25 25
	A DOCUMENT LIGITATION	23

xii Contents

Chapter 3	The Angular Distribution of Current from the Triode	
	Apparatus	27
	General Measurement Procedures	28
	Typical Distribution Curves—Effects of Cathode to Grid	
	and Anode to Grid Spacing Changes	30
	Effects of Grid Modulation	35
	Concept of the Cathode Image	36
	Application of Results to Normal Size Systems—Overall	
	Accuracy in Beam Current Assessment	38
	Use of Results in Aperture Imaging Cathode Ray Devices	38
	Associated Literature	39
Chapter 4 /	The Current Distribution across the Cathode Face	
	General Problem	41
	The Cathode Emissive Area	41
	Density Distributions across the Cathode Face Obtained	
	by Scanning	43
	The Split Cathode Experiment	44
	Preliminary Check and Effect of the Inter-Cathode Gap	45
	Influence of Triode Geometry on the Peak/Mean Ratios	47
	Quasi-Peak Emission Density Found from the Split Cathode	48
	Effect of the Modulation Characteristic Gamma on the	
	Peak/Mean Ratios of Emission Density	50.
	Reexamination of the Modulation Formulas	51
	Discussion and Literature	51
Chapter 5 /	Measurements on the "Narrow Angle Crossover"	
	by Aberrationless Imaging	
	Objectives	53
	Experimental Arrangements	53
	Preliminary Observations—Confirmation of Narrow Angle Conditions	59
	Effect of Focusing Voltage	61
	Effect of Anode Voltage Changes—The $V^{-1/2}$ Relationship	62
	The Semi-Normalized Spot Size Data	64
	Space Charge Correction at the Screen	68
	The Normalized Image Density Data	68
	Discussion	72
	Neutralization of Space Charge at the Screen by Residual Positive Ions	75
	Literature	77

Contents	xiii

	PART 2 / THE THEORETICAL MODEL	
Chapter 6	The Fundamental Limits in Electron Beams	
	General Objectives	81
	The Significant Common Feature of All Narrow Angle	
	Guns	82
	Basic Analysis of the Convergent Electron Beam	83
	Performance Limits—Mathematical Statement	86
	Concept of the Cathode Loading Limit in Narrow Angle	89
	Guns Literature Survey	92
	Literature Survey	92
Chapter 7	Deflection of Electron Beams	
	Introduction	97
	Electrostatic Deflection—General	98
	Nonparallel Plates	99
	Plate Synthesis	102
	Beam Track Calculations in a Tapered Plate Section	108
	Sensitivity Calculations for a Circular Plate	110
	Defocusing in Electrostatic Deflectors	111 113
	Defocusing in Magnetic Deflection	113
	Comparison of Defocusing in Rival Systems—Effects on General Design	116
	Literature Survey	117
	Literature Survey	11,
Chapter 8	Conformal Geometric Transformations in	
	Cathode Ray Tube Design	
	General Introduction	119
	The Overall Logical Progression	120
	Stage 1—Constancy of Scan Angle	122
	Stage 2—Transformation Paths	123
	Stage 3—The Enforced V , I , ρ_c Connections	126
	Stage 4—Physical Realizability	127
	Extension of Results to Electron Guns of Any Form	133 134
	Extension of Analysis to Systems with Aberrations	134
	Concept of the Mono-Directional Transformation General Conclusions on the Practical Validity of Conformal	130
	Transformations	137
	Relationship between Transformations at Fixed and Vari-	
	able Spot Sizes	138
	Continuity and Transformation "Severity"	138
	Literature	141

PART 3 / APPLICATIONS

Chapter	9	1	Feasibility	Assessments
---------	---	---	-------------	-------------

	Objectives Outline of Technique Determination of the Maximum Value of θ Determination of Beam Limit Performance—The Limit Diagram	145 145 146
	Superimposition of Langmuir Lines Cathode Loading Limits—Scale of Difficulty Line Literature	151 152 153
Chapter 10	/ The Concept of Improvement in Cathode Ray Tube Design	
	Introduction	155
	Consequences of the "Narrow Angle" Restriction	155
	Classification of Types of Improvement	156
	Literature and Discussion	165
Chapter 11	/ Typical Problems	
	Problem 1—A Gun for Use in a Demountable Tube for	
	Phosphor Irradiation	167
	Problem 2—Preliminary Investigation of Large Screen Direct Viewing Cathode Ray Tubes for High Resolution	
	Radar Systems—a Hundred Million Picture Point Tube Problem 3—Investigation of a Very High Resolution Tube	170
	of 5-in. Screen Diameter	173
	Problem 4—Derivation of a Projection Tube from a Direct	
	Viewing Prototype	175
	Problem 5—Design of the Prototype Magnetically De-	
	flected Electrostatically Focused High Resolution Tube	181
	General Conclusions Literature	188 188
	Literature	100
Appendix 1	/ Scaling of Electron Beam Devices	191
	Scaling Theory with Zero Initial Velocities	191
	Scaling with Initial Emission Velocities	195
	I it and the	100

Contents	XV
----------	----

	î	
Appendix 2	Some Properties of the Solid Gaussian Distribution	201
	Reference	203
Appendix 3 /	Simplest Proof of the Langmuir Thermal	
	Limit	205
	Conditions at the Cathode Image	205
	Conditions at a Crossover	211
	Analysis of the Limit Conditions	212
	Nearness-of-Approach to Langmuir-Limit and Fraction	212
	of Current Utilized	213
	Reference	215
Appendix 4 /	On the Question of "Equivalence" of Electron	217
	Beams in Derived and Prototype Tubes	217
Index		221