CONTENTS

Preface to the Third Edition		<i>page</i> xi	
Fro	m the Preface to the Second Edition	xii	
Ack	nowledgements	xiii	
	CHAPTER I		
	Historical introduction. The fundamental principles of electron optics		
ı.ı	Historical development	1	
1.2	Variation principles and the refractive index of an electron	l 2	
1.3	Image formation by collinear projection	9	
1.4	Line focus lenses	11	
1.5	The physical problem of image formation	13	
1.6	Electron optical brightness and the directional		
	intensity of a beam	15	
1.7	Conclusion	19	
	CHAPTER 2		
	The cardinal points of an electron lens		
2.I	Location of cardinal points by ray tracing with a sliding target	20	
2.2	Geometrical relations between object and image space		
2.3	Combination of lenses	26	
2.4	Practical methods for locating cardinal points	26	
2.5	Cardinal points of line focus lenses	30	
	CHAPTER 3		
	Field plotting and ray tracing: analogue		
	and computational methods		
3.1	Potential distribution and Laplace's equation	38	
3.2	Relaxation methods	41	
3.3	Analogue methods of field plotting	47	

vi	CONTENTS	
3.4	Ray tracing by Snell's law	page 54
3.5	Equations of motion of the electron	57
3.6	Determination of electron trajectories	59
	CHAPTER 4	
	Some electrostatic electron lenses	
4. I	General properties	65
4.2	Symmetrical two-tube lenses	66
4.3	Various two-electrode lenses	72
4.4	The single aperture	76
4.5	Multielectrode lenses	81
4.6	Saddle-field lenses	82
4.7	Electron mirrors	92
4.8	Gauze lenses	98
4.9	Electrostatic quadrupole lenses	100
	CHAPTER 5	
	Magnetic electron lenses	
5.1	Electron path in homogeneous magnetic fields	107
5.2	Paraxial rays in inhomogeneous magnetic fields of	\mathbf{f}
	circular symmetry. The thin lens	III
5.3	Focal length and image rotation of thick magneti	c
	lenses	115
5.4	Practical lens design	120
5.5	Permanent magnets. Superconductors	131
5.6	Determination of magnetic field distributions	137
5.7	Ray tracing through magnetic lenses	142
5.8	Combined electrostatic-magnetic lenses	148
5.9	Magnetic electron reflector and magnetic bottle	151
5.10	Magnetic quadrupoles	154
	CHAPTER 6	
	Lens errors: geometrical aberrations	
6.1	Classification of aberrations	159
6.2	Deviations from circular symmetry	162

	CONTENTS		vii
6.3	Spherical aberration	page	169
6.4	Spherical aberration: measuring methods		175
6.5	Spherical aberration: discussion of results and		
	possibility of correction		182
6.6	Field aberrations: coma		196
6.7	Field curvature and astigmatism		199
6.8	Distortion		206
6.9	Anisotropic aberrations		212
6.10	Aberrations of line focus lenses		214
6.11	Design of stigmatic lens systems with the help of lin	ne	
	focus lenses		221
	0334 DMDD -		
	CHAPTER 7		
	Electronic aberrations		
7.1	Chromatic aberration		225
7.2	The use of chromatic aberration in electron-lens		
	spectrometers		233
7.3	Filter lenses		244
7.4	Relativistic aberration		252
7.5	Space-charge error		254
7.6	Diffraction error		255
7.7	Combination of aberrations		264
	CHAPTER 8		
	Electron optics and space-charge		
8.1	Spreading of a homogeneous, homocentric beam		269
8.2	Application of laminar space-charge theory		276
8.3	Focus spread and focus shift. Space-charge equivale	nt	-
	lens		282
8.4	Aberrations of the space-charge equivalent lens.		
•	Non-laminar flow		285
8.5	Space-charge in interaction with electrodes and		·
-	electron lenses		290
8.6	Space-charge and positive ions		295
8.7	Balancing of space-charge pressure by external field	ls.	
	Confinement of high-density beams		300

viii	CONTENTS	
8.8	Electrode design, electrostatic fields and electron	
0 0	trajectories in presence of space-charges page	307
8.9	Minimum in the potential distribution along the beam. The virtual cathode	311
	The virtual currence	311
	CHAPTED	
	CHAPTER 9	
	Emission systems and electron guns	
9.1	The acceleration of the emitted electrons. Cathodes in	
	emission systems	320
9.2	Triode emission systems with plane cathode and their	
	use in emission microscopes and in television guns	323
9.3	Fields and electron trajectories in emission systems.	
	Cross-over formation	330
9.4	Optical approach to emission systems	335
9.5	Beam intensity modulation Design of simple triode systems with plane cathode	339
9.6 9.7	Aberrations in emission systems	345
9.7 9.8	Emission systems with concave cathodes	351 361
9.9	Hairpin and point cathodes in emission systems	367
9.10	Guns developed for special purposes	377
J		311
	CHAPTER 10	
	Deflecting fields	
10.1	Homogeneous weak deflecting fields	389
10.2	Practical electrostatic deflexion systems	392
10.3	Practical magnetic deflexion systems	402
10.4	Focusing deflexion in electrostatic fields	407
10.5	Focusing deflexion in magnetic fields	419
10.6	Superposition of electrostatic and magnetic fields	431
10.7	Deflexion errors	441
10.8	Deflexion-focusing errors, monochromatic line-	
	width and field correction	446
10.9	Dispersion, resolving power and collecting efficiency	
	of focusing deflexion fields	452

CONTENTS	ix
APPENDIX A. Potential distribution along the axis and off the axis in fields of circular symmetry page	462
APPENDIX B. Geometry of an emission system and the observed energy of electrons	465
APPENDIX C. Plotting of spectral distribution curves	468
APPENDIX D. Trajectory computation in electrostatic fields	473
Bibliography and Author Index	479
Subject Index	501