



# Contents

---

<b>Preface</b>	<i>page</i>	ix
<b>I Glow Discharge Phenomena</b>		1
1.1 Introduction and history		1
1.2 Visual phenomena of glow discharges		3
1.3 General electrical characteristics		9
1.4 The mechanism		13
<b>II Collisional Processes and Transport</b>		16
2.1 Atomic states		16
2.2 Types of collisions		21
2.3 Fundamental collisional phenomena in a weakly ionized gas		24
2.3.1 <i>Mean free paths.</i>	2.3.2 <i>Elastic scattering.</i>	
2.3.3 <i>Energy loss</i>		
2.4 Diffusion		30
2.5 Drift		33
2.6 Mean electron energy		38
2.6.1 <i>Elementary theory.</i>	2.6.2 <i>Experimental data</i>	
<b>III Ionization and De-Ionization Processes</b>		44
3.1 Electron attachment		44
3.2 Recombination processes		46
3.2.1 <i>Ionic recombination.</i>	3.2.2 <i>Electron recombination</i>	
3.3 Ionic dissociation		52
3.4 Electron detachment		53
3.5 Ionization coefficients		54
3.5.1 <i>Primary ionization.</i>	3.5.2 <i>Secondary ionization.</i>	
3.5.3 <i>Determination of effective ionization and attachment coefficients</i>		

3.6	Applications of ionization and de-ionization processes	57
<b>IV</b>	<b>The Discharge Passes. Transition to the Glow</b>	<b>59</b>
4.1	Setting up the space charge	
	4.1.1 <i>General considerations.</i> 4.1.2 <i>Space charge in vacuo</i>	
4.2	Sparking potential and maintenance potential	64
4.3	The fall of potential at electrodes	66
4.4	Dark spaces	70
4.5	Diagnostic techniques	72
	4.5.1 <i>Optical.</i> 4.5.2 <i>Charged beams.</i> 4.5.3 <i>Metallic probes</i>	
4.6	The Langmuir and Mott-Smith probe	75
	4.6.1 <i>Positive ion current.</i> 4.6.2 <i>Electron current.</i> 4.6.3 <i>Correction factors</i>	
4.7	Druyvesteyn's probe analysis	81
4.8	The similarity principle	84
<b>V</b>	<b>Electrode Phenomena</b>	<b>90</b>
5.1	Anode effects	90
5.2	Cathode phenomena	92
	5.2.1 <i>Values of the cathode fall.</i> 5.2.2 <i>Theories of the cathode fall.</i> 5.2.3 <i>Energy balance.</i> 5.2.4 <i>Abnormal cathode fall</i>	
5.3	Cathode sputtering	98
	5.3.1 <i>The phenomenon and its applications.</i> 5.3.2 <i>Mechanism</i>	
<b>VI</b>	<b>The Positive Column or Uniform Plasma</b>	<b>102</b>
6.1	Basic properties	102
6.2	Diffusion theory of the column	104
	6.2.1 <i>Radial particle distribution.</i> 6.2.2 <i>Radial potential distribution.</i> 6.2.3 <i>Determination of Townsend's <math>\alpha</math> in the glow.</i> 6.2.4 <i>Experimental data.</i> 6.2.5 <i>Similarity relationships</i>	
6.3	Microscopic theory of the column	115
6.4	Optical properties	118
6.5	Oscillations and noise	123

6.6	H.F. discharges	126
6.6.1	<i>Nature of the discharge.</i>	
6.6.2	<i>Types of excitations.</i>	
6.6.3	<i>Similarity, dimensions, gas pressure and frequency.</i>	
6.6.4	<i>Elementary theory of the mechanism when diffusion controlled</i>	
6.7	Discharges in non-uniform fields	135
<b>VII</b>	<b>Applications in Electronics and Plasma Physics</b>	<b>139</b>
7.1	Light sources	139
7.1.1	<i>Fluorescent discharge tubes.</i>	
7.1.2	<i>Street lamps</i>	
7.1.3	<i>Spectroscopic sources.</i>	
7.1.4	<i>Negative glow lamps</i>	
7.2	Lightning arresters	142
7.3	Applications in electronics	143
7.3.1	<i>Circuit impedances.</i>	
7.3.2	<i>Thin films and sputtering.</i>	
7.3.3	<i>High vacuum technique.</i>	
7.3.4	<i>Switch elements.</i>	
7.3.5	<i>Anomalous photo-electric effects.</i>	
7.3.6	<i>Gas discharges as rectifiers.</i>	
7.3.7	<i>Stabilizer tubes.</i>	
7.3.8	<i>Trigger tubes.</i>	
7.3.9	<i>Dekatron</i>	
7.4	Radiation or particle detectors	149
7.4.1	<i>Basic principles.</i>	
7.4.2	<i>Discharge processes in counters.</i>	
7.4.3	<i>Operating conditions</i>	
7.5	High current discharges	154
7.5.1	<i>Magneto-hydrodynamics.</i>	
7.5.2	<i>M.H.D. energy converter.</i>	
7.5.3	<i>Plasma propulsion.</i>	
7.5.4	<i>Thermionic plasma power converter</i>	
7.6	Highly ionized plasma	159
7.6.1	<i>Short-range and long-range Coulomb interactions.</i>	
7.6.2	<i>Debye length and screening</i>	
7.7	Thermo-nuclear power	165
7.7.1	<i>Basic fusion reactions.</i>	
7.7.2	<i>Experimental requirements.</i>	
7.7.3	<i>Pinch effect.</i>	
7.7.4	<i>Containment</i>	
7.8	Thermo-nuclear machines	170
7.8.1	<i>Linear and toroidal pinches.</i>	
7.8.2	<i>Theta pinch.</i>	
7.8.3	<i>Mirror or adiabatic trap machines.</i>	
7.8.4	<i>Rotating plasma.</i>	
7.8.5	<i>Stellerator.</i>	
7.8.6	<i>Ion injection machines</i>	

<b>VIII</b>	<b>Vacuum Systems</b>	173
8.1	General Principles	
8.1.1	<i>Domains of low pressure.</i>	
8.1.2	<i>Types of gas flow</i>	173
8.2	Low pressure and medium vacuum systems	180
8.2.1	<i>General equipment.</i>	
8.2.2	<i>Measurement of pressure.</i>	
8.2.3	<i>Low pressure of backing pumps</i>	
8.3	High vacuum systems	186
8.3.1	<i>General equipment.</i>	
8.3.2	<i>Ionization gauge.</i>	
8.3.3	<i>Pumps</i>	
8.4	Ultra-high vacua	193
8.4.1	<i>Pumping techniques.</i>	
8.4.2	<i>Pressure measuring techniques.</i>	
8.4.3	<i>Ultra-high vacuum system layout</i>	
	<b>Appendix. Atomic Constants</b>	200
	<b>References</b>	201
	<b>Index</b>	207

