

## CONTENTS

	Page
Chapter I Alloys in General; The Phase Rule	
1.1 Alloys and Their Importance	1
1.2 Alloy Systems	3
1.3 The Phase Rule	4
1.4 Applications of the Phase Rule	13
Chapter 2 Constitutional Diagrams; Simple Eutectic-Type Alloys	
2.1 Variation of Solubility with Temperature	21
2.2 The Zinc-Tin Eutectic	26
2.3 The Zinc-Tin Constitutional diagram	30
2.4 Interpretation and Usefulness of Constitutional Diagrams	31
2.5 Other Simple Eutectic-Type Alloy Series	44
2.6 Construction of Constitutional Diagrams; Thermal Analysis	46
2.7 Accuracy of Constitutional Diagrams	52
2.8 The Structure of Eutectic –Type Alloys	53
2.9 Undercooling	61
2.10 Properties of Eutectic-Type Alloys	63
Chapter 3 Binary Alloys Showing Mutual Solid Solubility	
3.1 The Phase Rule and Solid Solubility	67
3.2 The Copper-Silver Alloy Series	68
3.3 Interpretation of the Cu-Ag Constitutional Diagram	71
3.4 Cooling Curves for Copper-Silver Alloys	78
3.5 Microstructures of Copper-Silver Alloys	79
3.6 Other Eutectic-Type Alloy Series	82
3.7 Alloy Series in Which Solubilities Are Unlimited	84
3.8 Coring of Solid Solutions	90
3.9 Properties of Cored Solid Solutions; Homogenizing	93
3.10 Formation of a Eutectic as a Result of Coring	95
3.11 Undercooling	97
3.12 Precipitation Hardening (Age Hardening)	99
3.13 Effects of Aging Temperature	104
3.14 Other Precipitation-Hardenable Alloys	106
3.15 Strain Aging	109
3.16 Properties of Solid-Solution Alloys	111
Chapter 4 Intermediate Phases in Binary Alloy Series	
4.1 The Magnesium-Silicon Alloy Series	115
4.2 Intermediate Phases in General	118
4.3 Decomposition of Intermetallic Compounds	123
4.4 Peritectic Reaction; The Aluminum-Calcium Series	123
4.5 Peritectic Reactions in General	127
4.6 Peritectic vs. Eutectic Reactions; the Suppressed Mixim	129
4.7 Microstructure and Properties of Alloys Containing Compounds	131
4.8 Departures from Equilibrium	131
4.9 Complete Solubility with a Maximum	133
Chapter 5 Binary Alloys with Limited Liquid Solubilities	
5.1 Complete Insolubility in Molten Alloys	136
5.2 Limited Liquid Solubilities; The Monotectic Reaction	138
5.3 Other Alloy Series in which Monotectics Occur	141

## Chapter 6 Changes in Solid Alloys

6.1	Solubility Changes	143
6.2	Ordering of Solid Solutions	146
6.3	The Curie Temperature	147
6.4	Polymorphic Transformations	148
6.5	The Eutectoid Reaction	149
6.6	The Peritectoid Reaction	153
6.7	Interpretation of Complex Reactions	256

## Chapter 7 Alloys of Iron and Carbon; The Steels

7.1	Iron-Carbon Alloys	161
7.2	Peculiarities of the Iron-Carbon Diagram	162
7.3	Steel vs. Cast Irons	164
7.4	The Peritectic Reaction in Steels	165
7.5	The Eutectoid Reaction in Steels	168
7.6	Transformation of Austenite During Slow Cooling	170
7.7	Magnetic Changes in Steel	175
7.8	Cooling Curves for Steels; Thermal Arrest	177
7.9	Transformation of Austenite During Rapid	179
7.10	Transformation Rates at Subcritical Temperatures	183
7.11	The Bainite Transformation	185
7.12	The Martensite Transformation	188
7.13	The Instability of Martensite	193
7.14	The Complete TTT Diagram	194
7.15	Austenite Transformation During Continuous Cooling	195
7.16	The Heat Treatment of Steel	198
7.17	Austenite and Ferritic Grain Size	200
7.18	Specification of Grain Size	203
7.19	Grain Size Control	205
7.20	Inherent Grain Size	208
7.21	Effect of Hot Mechanical Working on Grain Size	209
7.22	Annealing in General	210
7.23	Process Annealing	210
7.24	Full Annealing	212
7.25	Normalizing	213
7.26	Quenching	214
7.27	Hardening	215
7.28	Retention of Austenite	218
7.29	Importance of Retained Austenite	220
7.30	Elimination of Retained Austenite	222
7.31	Cold Treatment	222
7.32	tempering (Drawing)	223
7.33	Tempering Temperatures	224
7.34	Spheroidizing	228
7.35	Hardenability	230
7.36	Hardenability vs. Maximum Hardness	232
7.37	Hardenability Testing	233
7.38	The Times Quench (Interrupted Quench)	234
7.39	Martempering	236
7.40	Austempering	238
7.41	Patenting	239
7.42	The Isothermal Anneal	240
7.43	Carburizing	241
7.44	The Carburizing Treatment	242
7.45	Gas Carburizing	244
7.46	Liquid Carburizing	245
7.47	Selective Carburizing	246
7.48	Heat Treatment After Carburizing	246
7.49	Nitriding	249
7.50	Advantages and Disadvantages of Nitriding	250
7.51	Carbonitriding	253

## Chapter 8 The Cast Irons

8.1	Types of Cast Iron	257
8.2	White Cast Irons	259
8.3	Malleable Cast Irons	263
8.4	Types of Malleable Iron	264
8.5	Gray Cast Irons	268
8.6	Freezing and Graphitization of Gray Irons	268
8.7	The Quality of Gray Cast Iron	271
8.8	Distribution of Graphite Flakes	273
8.9	Graphite Flake Size and Its Control	278
8.10	Chilled Cast Irons	281
8.11	Nodular Cast Irons	284
8.12	Heat Treatment of Cast Irons	288

## Chapter 9 Ternary and Higher Alloys

9.1	Phase Rule for Ternary Alloys	290
9.2	Ternary Models	293
9.3	Ternary Alloys Showing Complete Mutual Insolubility When Solid	297
9.4	Isothermal Sections	302
9.5	Vertical Sections	305
9.6	Ternary Series Showing Complete Mutual Solubility When Solid	307
9.7	Ternary Series with Minima or Maxima	311
9.8	Ternary Series in Which Solid Solubilities Are Restricted	311
9.9	Ternary Series Containing Intermetallic Compounds	317
9.10	Other Series Involving Binary Compounds	320
9.11	Other Types of Ternary Alloy	321
9.12	Departures from Equilibrium	321
9.13	Quaternary and Higher Alloys	322
	Index	327